REFINER
AND NATURAL GASOLINE MANUFACTURER

DECEMBER, 1935
Vol. 14, No. 12

A Gulf Publishing Company Publication
EDITED MONTHLY AT HOUSTON, TEXAS

Copyright, 1935

GEORGE REID
Editor

CONTENTS

Special Features

Operation on Three Types of Pennsylvania Charging Stocks . . . 555
E. M. Head and W. H. Rockman

Design and Operation of Bradford-Penn Chlorex Plant 558

Estimated Reid Vapor Pressure From A. S. T. M. Distillation Data 562
Harold M. Trimble and Jules O. Richardson

New Canfield Unit Improves Efficiency 565

Metallizing in Industry 567
H. R. Leland

Improvements Aid Norwalk Plant 571

Vacuum Unit for Lube Distillate 573

Novel and Efficient Scrubber Control System 574

The Carbon Dioxide Recorder and Its Use 575
Henry Cooney

Bolivar Refinery Improves to Produce Special Naphthas 576
J. C. Albright

Primary Distillation Unit Has Interesting Operating Features . . 579

Distillation Unit Is Designed for Double Duty 581

Combined Preheater, Trap and Boiler Feedwater Heater 582

Internal Treatment of Boiler Waters 584
J. S. Walton

Isopentane 583
I. N. Beall

Novel Blow-Down System at British-American Refinery 590

Regular Departments

The Look Box . . . . . 553 and 37a

Plant Activities 44a

Business Notes 46a

Ideas 51a

Science and Technology (Abstracts) 54a

New Equipment for the Modern Plant 64a

Catalogs and Bulletins 67a

Advertisers' Index 68a

SPECIALIZED OIL JOURNALS

Published by

GULF PUBLISHING COMPANY

OFFICE OF PUBLICATION
3301 Buffalo Drive, Houston, Texas

R. L. DUDLEY, *President*
A. L. BURNS, *Gen'l Manager*
S. W. ROBINSON, *Editorial Director*
J. KENT RIDLEY, *Managing Editor*

NEW YORK: Room 1023, 250 Park Avenue, Dick Swinsky, Manager.

PITTSBURGH: 902 Standard Life Building, W. W. Pigue, Manager.

CHICAGO: Room 1834, 332 So. Michigan Ave., T. W. Nelson, Manager.

LOS ANGELES: 416 Haas Building, W. E. Green, Manager.

TULSA: 1020 Hunt Building, J. F. Carter, Jr., Manager.

FORT WORTH: 203 W. T. Waggoner Building, H. H. King, Manager.

Single copies 20 cents. Domestic subscription price $1.00 a year. Canada and Foreign subscription price $2.00 a year. Entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879. Advertising rates on application.

ALCO

Announces~

its appointment as the licensing agent for the installation of Polymerization Plants under the comprehensive patent rights of the Pure Oil Company

Extensive research of more than eight years in the field of thermal and catalytic polymerization, coupled with five years of commercial operation of Polymerization Plants, is your guarantee of performance

Alco makes available this service for the economic development of your problem

●

ALCO PRODUCTS INCORPORATED

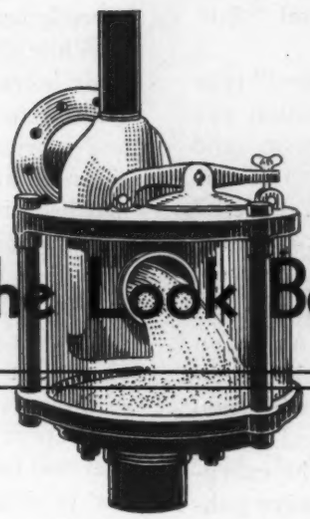
220 EAST 42nd STREET **NEW YORK, N. Y.**

DIVISION OF AMERICAN LOCOMOTIVE COMPANY

VOLUME 14, No. 12 DECEMBER, 1935

REFINER
AND NATURAL GASOLINE MANUFACTURER

A GULF PUBLISHING COMPANY PUBLICATION



The Look Box

THIS being the final issue of Volume 14 of THE REFINER, its editors want to be retrospect and review something of what the past twelve issues have brought its readers in practically every operating petroleum refinery in the world and in a very large majority of the operating natural gasoline plants.

Last Year and Next

At the close of the year 1934 THE REFINER promised its readers in these columns that, as in the past, this journal would continue to devote its work to the presentation of latest available information on engineering progress and technical development in refining of petroleum and manufacture of natural gasoline. That has been done, we hope satisfactorily, through the publication of 140 articles in the 12 issues comprising Volume 14.

These important discussions have covered a wide range of subjects, all of them dealing directly with the problems bearing directly on the manufacturing branch of the petroleum industry to which branch THE REFINER is exclusively devoted. Let us cite several of the subjects covered: liquefied gases, evaluation of oil stocks, efficiency of fractionating columns (six articles), salvaging refinery wastes, work on emulsions, compressor station problems, gum in gasoline, instrument maintenance, pump selection, blending lubricants, thermodynamics of light hydrocarbons (four articles), design of gasoline plants, new asphalt process, new gas purification process, percolation filtration, chemical refining (six articles), corrosion, safety developments, solvent refining and dewaxing (seven articles), doctor solution as a research problem, depreciation, obsolescence, metallurgy (three articles), vacuum refrigeration, anti-knock factors (two articles), Diesel fuels, lubricating oil technology (five articles) gas handling and processing (three articles) stabilization (three articles), cracking technology (three articles), carbon black manufacture, foundation design, molecular weight methods, reclamation of lubricating oils, motor fuel testing, lubricating greases, internal water treating, and polymerization (five articles). This partially covers the engineering and technical data presented in these pages during the last 12-month period. THE REFINER feels just a little proud of having had opportunity to present such an array of technical and engineering information to its readers throughout the world.

In addition, however, the apparently ever-pop-

ular type of article which describes the design, construction and operation of actual installations was not in the least overlooked. During the life of this volume, 44 such articles have been presented. The editors wish to take this opportunity to thank those companies which have permitted their processing facilities to be described, and to thank those of the supervisory personnel who have so kindly given of their time that the representatives of this journal could secure the detailed information for publication. Ten cracking installations were described, sixteen articles dealt with distillation or general refining, twelve articles dealt with natural gasoline manufacturing facilities, and six were of the general "plant method" type.

During the year the short "plant method" type of article was supplanted by the innovation and continuance of the "Ideas" department, and through the friendliness of contributors it has been possible to present a total of 47 "Ideas" during recent months. There are many on hand, more are coming in, and many more can be used.

Of the total articles published this year twenty-three very important papers from the American Petroleum Institute, and one or two other technical societies were published, along with two translations from the German technical press. The remaining 115 articles were, with the exception of three or four, prepared for exclusive publication in THE REFINER. And this is another condition of which the journal is proud, for it indicates the growing tendency upon the part of those willing and qualified to write, to express their views and give of their knowledge through the columns of the only journal exclusively devoted to the presentation of data dealing directly and only with the problems ever confronting the manufacturing branch of the industry.

Volume 15, which begins with the January, 1936, issue, promises to be stronger from a technical and engineering viewpoint than the volume just closing. It is planned that a deal of attention will be given to engineering and to the economical application of engineering data to plant design, construction and operation. "Engineering Economics," discussed sometime ago in these columns probably will show up many times during the next year or so. A group of well known men in the industry have contributed or plan to contribute to a series of highly important discussions, which will appear only in this journal. And again, the same promise as has been made during the past years of THE REFINER'S life, and that is, its work will continue to be that of presenting the latest available information on engineering progress and technical development in refining of petroleum and the manufacture of natural gasoline.

New Cars and Old

The petroleum industry's refinery technologists and engineers have to be magicians and contortionists, lose many nights' sleep,and become prematurely gray of hair, to keep abreast of the constantly changing and sometimes whimsical gasoline and lubricant requirements imposed upon the refining industry by the automobile makers. This is the impression conveyed in the recent report of the Automotive Survey Committee of the American Petroleum Institute. And on that general thought, few take issue so far as past experience has been. Closer contact between the two industries and cooperative investigations are speedily tending to make smoother progress.

While the auto makers are interested primarily in increasing the sale of new cars, it was pointed out, the oil industry lives primarily by fueling and lubricating cars of all ages. Of the cars on the road at the end of 1934 only thirteen percent had been built during that year and nine percent the previous year; while fifty percent were five years old or older.

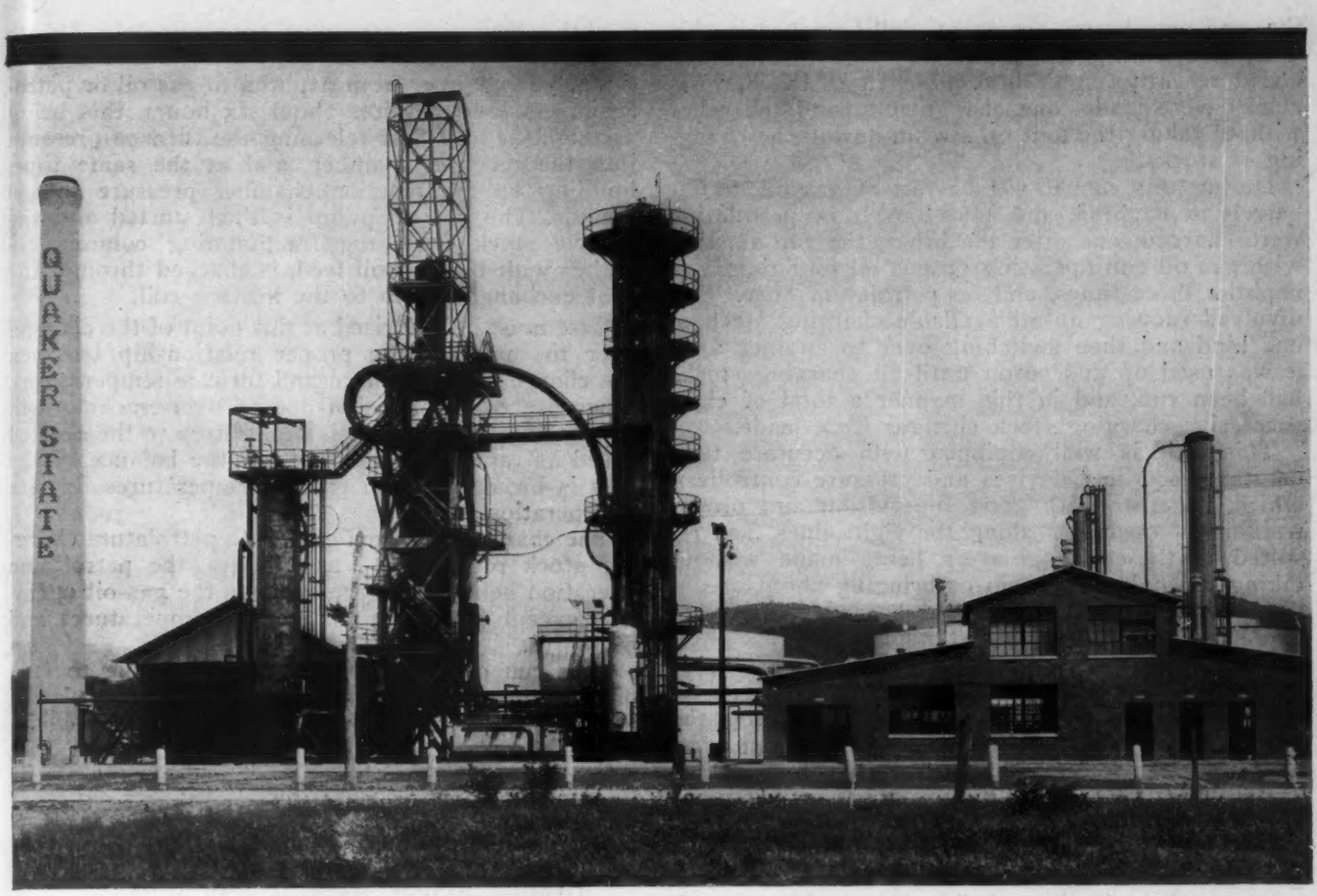
While taking care of the needs of the millions of older cars, the petroleum refining industry is obliged at the same time to fill the requirements of the cars of new design. This situation has led, the report states, to difficulty in supplying the fuel and lubricating requirements of the different car models, while the oil refiners have had to bear heavy costs of research and installation of new equipment.

Automobiles requiring over 70 octane gasoline, for instance, represent only 1.4 percent of the total cars registered. Yet the oil industry has been obliged to install special equipment for supplying such gasoline.

Moreover, the oil industry sometimes has been left holding the sack when automotive designs requiring special oils and lubricants, or thought to require them, have proved only temporary. For example, the history of free-wheeling was cited, for which special lubricants were developed and about the time when good distribution was secured it was discovered that free-wheeling required nothing abnormal in the way of lubrication. Free-wheeling today appears to be vanishing after going strong for a short period.

For the refining industry the only apparent worth while way out appears to be much closer cooperation and much more frequent contact with automobile designers and manufacturers. As conditions exist at present, viewing both the influences of automotive design trends, and the presence of much too much obsolete equipment on the yards of the refineries, the "way out" is simple if there is money in the bank, and the answer is modern equipment.

(*Please see page 37a*)



Dubbs Cracking-Reforming Unit, McKean Plant, Quaker State Refining Company

OPERATION ON Three Types *of* Pennsylvania Charging Stocks

E. M. HEAD *and* **W. H. ROCKMAN**
Quaker State Oil Refining Corporation

THE QUAKER STATE OIL REFINING CORPORATION completed the erection of its modern Dubbs cracking unit at its McKean Plant, located at Farmers Valley, Pennsylvania, in May, 1933. It was described in THE REFINER, in February,, 1934, page 44.

This new Dubbs unit included all the latest engineering features incorporated in modern cracking plant design. It is designed to process any cracking stock available from the McKean Plant, which involves naphtha reforming; kerosene, gas oil and petrolatum cracking or cracking mixtures of any of these stocks. The motor fuel produced from this unit is blended with light straight-run gasoline from the refinery topping plant and is treated with Universal inhibitor and requires no further chemical treatment. Vapor pressure and octane rating specifications are secured over a very flexible range to meet the changing market and seasonal conditions.

This unit has a rated capacity of 1250 barrels per day when operating on gas oil and 1500 barrels per day when on naphtha. However, it has operated successfully with a throughput of 1600 barrels of gas oil or 1850 barrels of naphtha per day. When operating on naphtha, the yield of gasoline runs from 77 to 79 percent, on kerosene from 74 to 75 percent, and on gas oil from 70 to 71 percent. This plant is operated to secure a high anti-knock rating on the finished, blended and inhibited motor fuel.

Two flow charts indicating the difference in the two methods of operation, recycle for heavy oil, either gas oil or petrolatum, and the once-through for naphtha reforming, are shown.

Three Pennsylvania charging stocks, gas oil, naph-

tha, and petrolatum, are successfully cracked in this unit, and during a continuous 82-day run which ended recently, eight different changes in charging stocks were made, one change following the other without taking the unit off stream during the changing of stocks.

During this run, 69,671 barrels of gas oil, 53,051 barrels of naphtha, and 4409 barrels of petrolatum were charged, one after the other, the run starting with gas oil and operating on gas oil four times, on naphtha three times, and on petrolatum once. This involved running up all available charging stock of one kind and then switching over to another until it was used up and so on until all charging stocks had been run, and in this manner a total of eight successive charging stock changes were made.

This unit is well equipped with accurate temperature recording devices and pressure controllers, which, together with good supervision and proper training of operators along the right lines, has resulted in these change-overs being made without taking the unit off stream or bringing about a condition which might be termed hazardous from an operating or coke forming standpoint.

The change-over from gas oil to naphtha is made by first cutting out the hot oil pump as no recycle stock is returning to the heating coil during the naphtha operation. Any heavy ends not taken overhead from the fractionator with the gasoline stream are withdrawn from the base of the fractionator to storage, and are finally cracked with the gas oil charge as these heavy ends usually are within the gas oil boiling range characteristics.

The naphtha is charged direct to the heating coil and a pressure of 600 pounds is maintained on the furnace by means of a remote control valve in the transfer line and prior to the reaction chamber. Quenching is done in the transfer line and the reaction chamber pressure is lowered to 150 pounds during the naphtha operation. The unit is then brought to the temperatures required for naphtha reforming, the total change-over from gas oil to naphtha operation requiring approximately 3½ to 4 hours.

The change-over from naphtha to gas oil or petrolatum cracking requires about six hours, this being accomplished by first releasing the furnace pressure into the reaction chamber, and at the same time, building up the reaction chamber pressure to 400 pounds. The hot oil pump is then started and the recycle stock from the fractionating column, together with the raw oil feed, is charged through the heat exchanger tubes to the heating coil.

Care must be exercised at this point of the change-over to maintain the proper relationship between the charge to the furnace and furnace temperatures, otherwise coke formation due to over-cracking will result. The hot oil pump is brought up to the desired speed as rapidly as possible and the balance of the unit is brought to the proper temperatures for gas oil operation.

The change-over from gas oil to petrolatum charging stock requires 1½ to 3 hours, the petrolatum operation being much the same as the gas oil operation except for minor changes in temperatures and pressures.

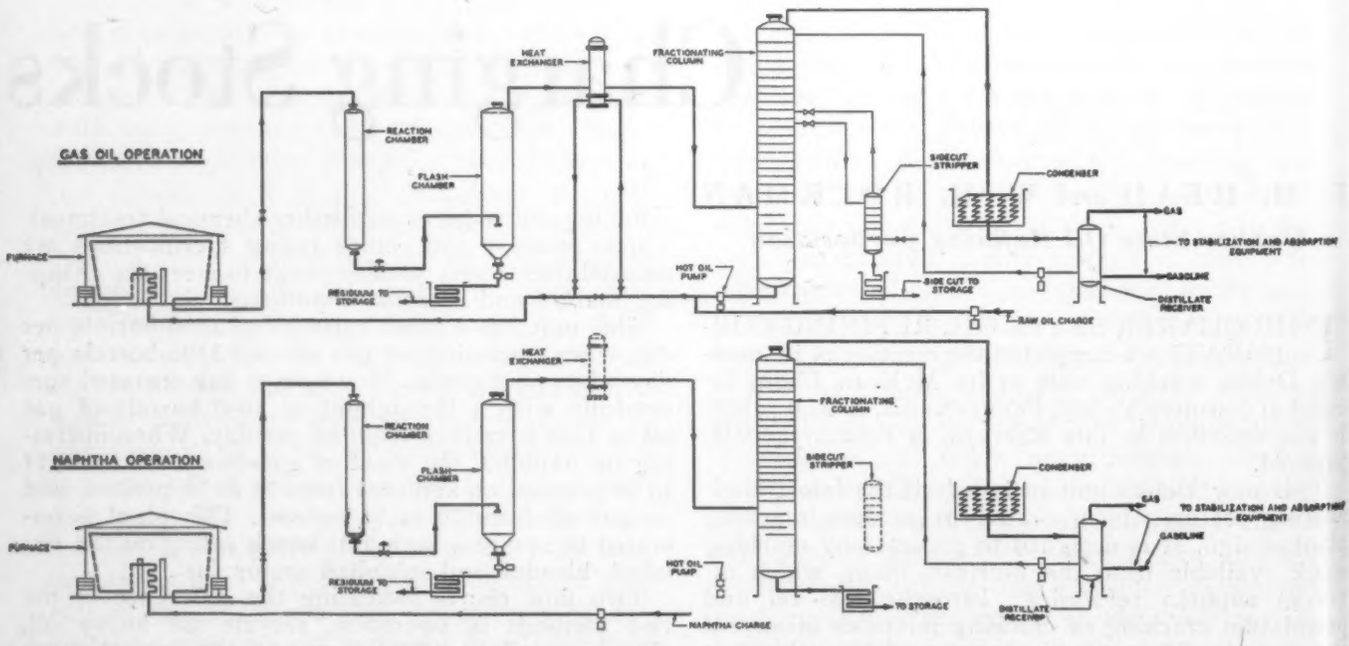
This run of 82-days was terminated due to running out of charging stock, as all available stock had been processed, and it was evident from the condition of the plant, when opened up for cleanout, that this run could have been continued for a greater length of time. The plant coke conditions at the end of this run were as follows:

Furnace—Convection Section: Dusty.
Heating Section: Dusty to 1/16" of coke.
Soaking Section: 1/16" of coke (real hard formation).

Transfer Line—1/16" to 1/4" of hard coke.

Reaction Chamber—Top half of shell: about ½" of coke which was not cleaned out. Bottom half of shell: ½" to ¾" of hard coke which nearly all fell off the wall when chamber was opened.

Flash Chamber—Considerable coke on bottom head



Combined Flow Chart of Quaker State Unit, showing the two methods of operation—Recycle for heavy oil, once through for reforming naphtha.

TABLE 1

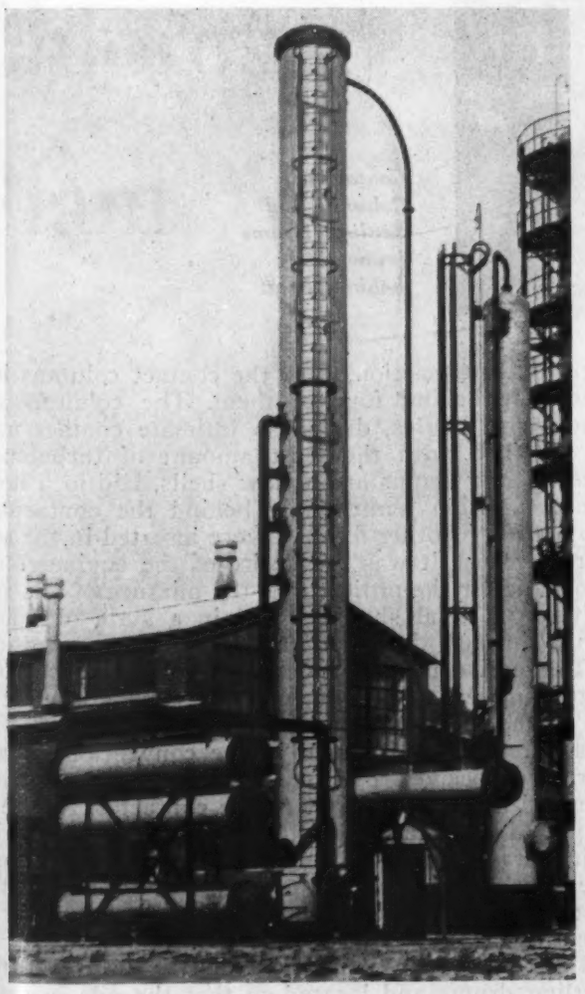
Stocks Processed	Barrels	Hours on Stream
Gas oil (No. 1)	7,923	116
Naphtha (No. 2)	14,513	236
Gas oil (No. 3)	26,438	453
Naphtha (No. 4)	18,921	263
Petrolatum (No. 5)	4,409	46
Gas oil (No. 6)	20,592	344
Naphtha (No. 7)	19,617	289
Gas oil (No. 8)	14,718	230
Total	127,131	1,977

and on walls up to inlet. About 3/8 of an inch of fairly hard coke on baffles. Down pipes from top deck were plugged full of coke and enough soot had gathered on deck to cover bubble caps.

Fractionating Column—About 100 pounds of soot in bottom.

A total of 22 wheelbarrow loads of coke was removed from the entire unit.

In the Quaker State Oil Refining Corporation plant at Farmers Valley, Pennsylvania, the amount of charging stock is limited as it consists of the different grades of stock made from the plant crude throughput and this means that a flexible cracking unit, able to produce high octane gasoline from each charging stock, is necessary.



Stabilizing unit at cracking plant, where the light straight run and the cracked gasoline are blended, stabilized, and inhibitor added.

TABLE 2
Properties of Charging Stocks 100 cc Engler Distillation

	Gas Oil	Naphtha	Petrolatum
Gravity, ° A.P.I.	39.4	54.2	30.0
I. B. P., ° F.	290	240	300
5 percent	...	...	... Flash–500
10 percent	444	262	588 Fire–625
20 percent	518	272	650 Vis. at 210–105.4
30 percent	540	282	678 M.P.–126.2
40 percent	559	292	681
50 percent	573	304	704
60 percent	589	316	711
70 percent	606	329	717
80 percent	631	345	717
90 percent	657	364	717
95 percent	...	...	...
E. P., ° F.	684	409	717
Rec., percent	98.0	98.1	96.0
Percent at 400° F	7.0	97.0	2.0

TABLE 3

Item	Gas Oil	Naphtha	Petrolatum	S.R. Gasoline	Total
1. S.R. gasoline chgd. bbls.	.....	.....	.....	39,386	.....
2. Stabilization loss, bbls and percent	.....	.....	.....	1,044–2.65%	.....
3. Stab.S.R. in cracked gasoline, bbls.	.....	.....	.....	38,342	.....
4. Net raw oil chgd. to unit, bbls.	66,832	53,051	4,409	.....	124,292
5. Slop charged to unit, bbls.	575	.....	.....	.....	.....
6. Side cut charged to unit, bbls.	2,264	.....	.....	.....	.....
7. Total charge to unit, bbls.	69,671	53,051	4,409	39,386	166,517
8. No. runs chg. stock.	4	3	1	.....	8
9. Total hours run	1,143	788	46	.....	1,977
10. Total days run	47.6	32.8	1.9	.....	82 da. 9 hr.
11. Ave. thruput day	1,463	1,617	2,320	.....	.....

	Gas Oil		Naphtha		Petrolatum		Total	
Yields	Bbls.	Percent	Bbls.	Percent	Bbls.	Percent	Bbls.	Percent
12. Cracked gaso.	48,840	70.1	40,530	76.4	2,029	46.0	91,399	71.9
13. Side cut	160	.2	2,484	4.7	.....	....	2,644	2.1
14. Residue	9,324	13.4	1,109	2.1	1,855	42.0	12,288	9.7
15. Slop	219	.3	.....	....	.....	....	219	1.5
16. Gas in bbls. charge	11,046	15.9	8,928	16.8	543	12.3	20,517	16.1
17. Gas in M cubic feet	44,184	....	35,712	....	2,172	....	82,068	....
18. Gas cu. ft. bbls. of charge	634	....	673	....	493	....	646	....
19. Total recovery	69,589	99.9	53,051	100.0	4,427	100.3	127,067	99.9
20. Recovery + or —	—82	.1	.....	....	+18	.3	—64	.5
Fuel								
21. Fuel used, M cu. ft.	32,952		14,664		1,168		48,784	
22. Fuel used cu. ft. bbl. charge	473		276		265		384	
23. Fuel used in bbls. of charge	8,238		3,666		292		12,196	
24. Fuel used, percent of charge	11.8		6.9		6.6		9.6	

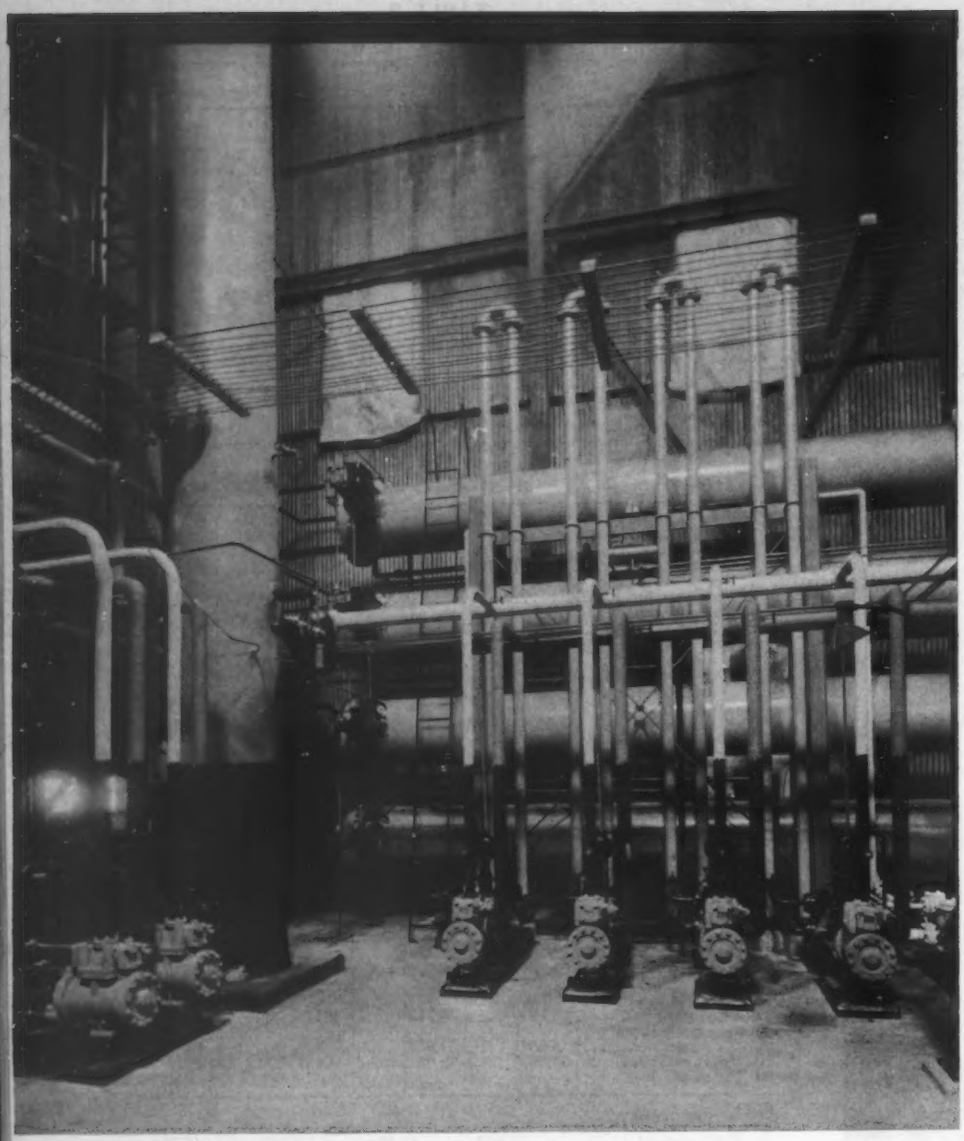
TABLE 4
Properties of Finished Stabilized Blended Straight Run and Cracked Gasolines

	Gas Oil	Naphtha	Petrolatum
Gravity, ° A.P.I.	63.6	63.8	62.1
I. B. P., ° F.	88	89	90
5 percent	...	...	...
10 percent	129	131	140
20 percent	152	159	164
30 percent	178	186	190
40 percent	201	208	216
50 percent	228	229	248
60 percent	257	239	266
70 percent	285	272	286
80 percent	310	303	312
90 percent	348	336	350
95 percent	368	...	...
E. P., ° F.	380	375	396
Rec., percent	97.8	96.0	97.0
Octane C.F.R.	66.0	66+	64+

TABLE 5
Properties of Cracked Residues

	Gas Oil	Naphtha	Petrolatum
Gravity, ° A.P.I.	3.0	16.7	23.2
Flash, °F.	215	175	240
Fire, ° F.	300	225	350
Vis. at 100° F.	...	...	...
Vis. at 210° F.	86	37.8	71
Pour, ° F.	20	Zero	85

Design and Operation of



Contacting Columns and Settling Drums immediately behind them.

OF THE solvent refining plants operating in Northern Pennsylvania and Western New York, Bradford-Penn Refining Company's unit at Clarendon, Pennsylvania, is the only one completely housed to protect it from the weather. This plant was built by company engineers, from designs made by them, in six weeks from the time the first concrete form was run, until the plant was in operation. Housing of the unit was made possible, without additional outlay of capital investment, by the fact that a steel building had previously been erected which contained the clay burning equipment, and which was designed with sufficient room to include a duplicate installation of rotary furnaces for revivification of the decolorizing clay used in lubricating oil manufacture.

The plant is not a large one, in barrels of output. The capacity varies as to the type of charging stock. The plant processes up to 400 barrels of steam refined stock and up to 600 barrels of neutrals per day. It is a continuously operated, self-contained plant, having all the necessary equipment arranged in the building to carry on the full operation, with the exception of steam generation. This is furnished by the boilers located nearby in the refinery.

The flow of oil and solvent (chlorex) is handled by a set of steam-driven reciprocating pumps, set in a convenient position, with the contact columns immediately behind four of them. The columns are made with baffles, drilled so intimate contact may be obtained with the least amount of turbulence. The settling drums are hollow shells, laid in a horizontal position immediately behind the contactors. No baffles, or other fixtures were inserted in the settlers, because it was the desire of the engineers responsible for the project that the mixture of oils and solvent material should travel in a state of quiescence through these settlers to facilitate separation.

The entire unit was designed for, and equipped with complete automatic controls, so that when it is in balance it requires very little supervision. The oils, after being dewaxed in the conventional manner, are received by the pumps at the unit and pumped through the first of the contactors where it is placed in intimate mixture with solvent material being drawn from the settlers. The flow is through the series, and when in the course of processing the last contactor is reached, fresh solvent material is used for the final finishing touches.

Liquid-level controllers are used on all four of the settling drums and located so that the oils in process and the solvents may be handled in the most economical manner. The pumps are controlled by automatic equipment so the speed is governed ac-

Hot Oil Belt Heater with Raffinate column to right.

Bradford-Penn Chlorex Plant

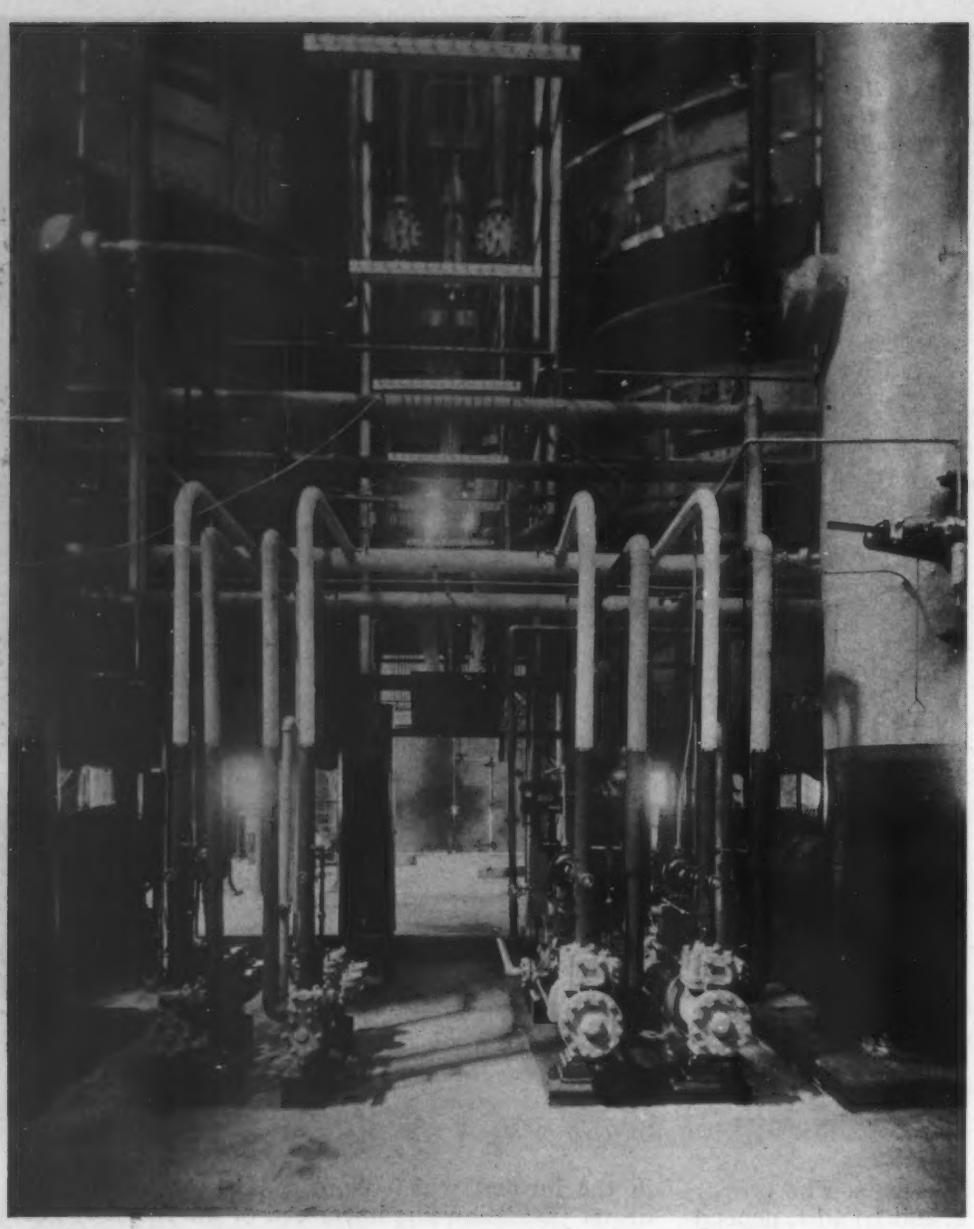
cording to the flow of oil and solvents. The proportion of solvents is from 0.9 to 1, and 1.1 to 1, depending upon the final desired results.

As compared to the previously operated lubricating plants, the material extracted from the stocks represents an average of 8½ percent, with the extract running from 7 to 10 percent. This material taken from the stocks represents a loss, when compared to refining Pennsylvania lubricating oils in the conventional manner where a solvent plant is not used in the process. With the extract solution, approximately 85 percent of the whole is solvent, while the raffinate, being approximately 91½ percent of the charged stock, contains only about 15 percent solvent. Both the raffinate and extract are treated in columns for the removal of solvents.

When solvents were first investigated by the company, solvents were removed from the raffinate and extract by direct fired stills, but because of the delicate handling necessary to prevent decomposition, fire as a direct heating medium was discarded in the design of this unit. Oil in circulation is used to heat the materials, and this travels through what is called a hot oil belt. A vertical oil heater was designed which contains flues, or tubes similar to a fire tube boiler. A stack is provided to carry away the products of combustion, and oil is used for fuel in the burner, which is placed in the skirt of the heater just below the lower end of the tubes. A good quality of fuel oil, which means a material similar to furnace oil, is used for the circulating and indirect heating medium. This is handled by pumps controlled by remote instruments, governed by the temperature at the point of use, and affecting both the fire under the heater and the pump which circulates the oil through the furnace, oil belt and heaters in the solvent stripping columns. This oil is circulated continuously through a closed system, consisting of the direct fired tubular heater, the lines carrying it, and the exchangers where it effects the removal of the solvents from both the raffinate and the extract. All of this equipment, raffinate column, extract column, settling drums, contactor columns and heating element, was fabricated by one of the nearby equipment manufacturers. The pumps are all of the close clearance type designed for precision operation.

The time of contact in the contactors behind the oil and solvent pumps was worked out so the time runs between one and two minutes, depending upon the type of oil charged to the solvent unit. The size of the settling drums was fixed to permit a settling time of abou 30 minutes.

The oil which has been selected to be solvent



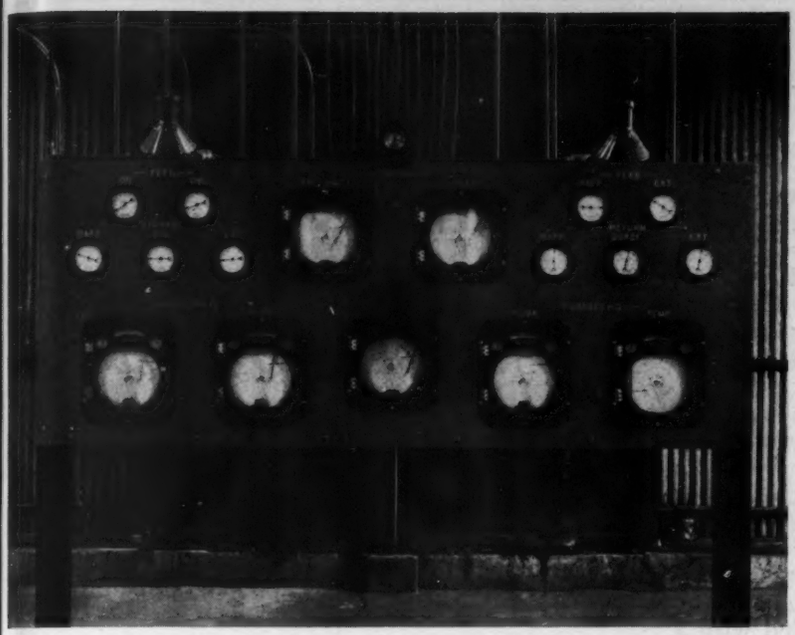
Column Control Pumps in chlorex plant.

treated is pumped to the first contactor column, all four of which are "U" tubes inverted and filled with drilled orifice plates. The temperature of the oil in process ranges from 60 to 125° F., depending upon the stock being treated and the results to be obtained. The solvent also is pumped to this contactor column, after it has been used in the three succeeding columns, and therefore is contacted three times with the same oil in process. The mixture of solvent and oil being treated empties from the first column into the first settling drum, from which the extract is removed by float control in the interface and pumped to the extract stripping column.

The oil, which now has been contacted for the first time, flows through the succeeding three contact columns under the initial pump pressure, and is contacted each time with counter flowing solvents, until it arrives at the last of the columns, or number four in the series, where it receives treatment with fresh solvent from the working tanks. From the last settler in the series, the raffinate solution is again picked up by an automatic controlled pump and is discharged to the raffinate solution stripping column where the solvent is removed from the oil.

The solvent recovery system is operated at from 80 to 100 millimeters, absolute pressure. The incoming raffinate solution treated in one column, is heated by exchange with outgoing raffinate and overhead vapors from the raffinate column. The heat for final extraction is obtained by the circulating hot oil from the "hot oil belt," and the charge flashed to the column at from 300 to 325° F. The "hot oil belt" also furnishes additional heat for stripping by the circulation of part of this stream through a reboiler at the base outlet of the column. The maximum temperature carried on the hot oil is limited to about 450° F. so that no danger of decomposition of the solvent solution is encountered. The stripped raffinate flows from the base of the stripping column through the action of a liquid-level controller, entering the base exchanger, and then is cooled before flowing to storage.

The extract flow is similar to the raffinate flow, but no exchange of heat is effected between the outgoing stripped extract and the incoming extract solution. The upper section of the extract column, which is the rectifying section, is much larger than the one on the raffinate solution column because of



Control Board in chlorex plant.

the larger amount of solvent solution contained in the extract. Both the recovery columns are provided wih exhaust steam connections where this steam is introduced at the base of the columns to aid in stripping the two materials. Both the condensed water vapor from the introduced steam and the solvent are cooled in a common unit attached to both the raffinate solution and the extract solution columns, and enter the barometric leg from which they are taken to be separated by gravity.

The water coming from the separator, where the solvent and the condensed vapor from the process steam are separated by gravity, contains about one percent of solvent. The solvent used boils at a much higher temperature than does water, but the two, when in solution, form what is called a minimum boiling mixture. The water containing this small amount of solvent is preheated again and flashed to a packed water column where live steam is used to vaporize the solvent which is subsequently condensed and passed back to the working tanks for reuse. The loss of solvent in this plant is estimated to be about four one hundredths of one percent, and that amount is accounted for through handling, sampling and loss by spills and other leaks.

Because the operators in the solvent unit were not too familiar with the process, or what was expected of it in the beginning, all lines, carrying products, solvents, water and steam were marked by painting a distinctive color on them after they were installed and insulated.

Air lines are laid to other lines so that they can be purged quickly of the stock which has been processed in the preceding run, if another class of oils are to be treated. By cleaning them in this manner, only a small amount of mixed oils are on hand, and the cost of operation is reduced appreciably.

The loss in this type of solvent plant runs from seven to ten percent, depending upon the stock treated and the specifications desired on the finished lubricants. The viscosity may be reduced within considerable limits at the operators' desire. A 150 at 210 viscosity bright stock may be made into a product having a viscosity of 140 at 210 by treating with the solvent unit. The V. I. may be raised to near 120 by the normal operation of the solvent unit. Sludging is greatly eliminated in this plant; oils showing normally an "Indiana" sludging time of 50 to 55 hours is raised to about 200 hours after being treated with the solvent.

Pumps useed in chlorex plant.

Estimating Reid Vapor Pressure From A. S. T. M. Distillation Data

HAROLD M. TRIMBLE
and
JULES O. RICHARDSON
Phillips Petroleum Company

THE idea of estimating vapor pressure from the distillation characteristics is not new. Bridgeman, Aldrich and White published a relationship for arriving at approximate "true" vapor pressure in 1929[1]. Oberfell, Alden and Fitch presented relationships of the initial boiling point and the five percent evaporated temperature to the vapor pressure early in 1928[2]. Improvements over these methods have been offered at various times.

All correlations attempted to date have adequately demonstrated that no relationship, based on a single distillation point, can be built up which will give satisfactory results on all gasolines, but that accuracy on occasional extreme products must be sacrificed to quickly and conveniently secure accurate results on the more conventional products. In general, it can be said that some distillation point in the fore part of the curve when properly coupled with a correction factor expressed either as one or two other distillation points or as the slope of the curve at the chosen point gives a method of approximating vapor pressure within the desired limits of accuracy.

The estimation of the vapor pressure of a gasoline is very useful when only distillation data are available and the Reid vapor pressure is needed. It is also desirable to have a means of checking the Reid vapor pressure and A.T.S.M. distillation determinations against each other. Several such methods have been used by this company during the past several years. They have proven very valuable for determining whether or not the Reid vapor pressures and A.S.T.M. distillations were satisfactory.

One of these methods[3] worked very satisfactorily on practically all types of gasolines but the procedure by which the correction factor was determined made this method both unwieldy and time-consuming.

This report presents the results of a study to develop a method which would require little time and still give reasonably accurate values.

DATA USED

The data used in developing this method were taken from the Phillips Petroleum Company Motor Fuel Laboratory files and represent samples secured during the last three years. The test methods used were A.S.T.M. throughout, with some additional precautions taken for greater accuracy.

The Reid vapor pressures, although run in accordance with Method D 323-32T, are believed to be a close approach to what might be expected of Method D 417-35T. Several precautionary steps, provided for in the latter method and not specifically excluded from the former, were observed in all determinations. These steps were as follows:

(a) All samples were cooled to 32° F. before pouring.

(b) Special precautions were taken to purge the Bourdon tube of the gauge of residual gasoline.

(c) Gauge corrections, determined by checking the gauge at the point of "uncorrected vapor pressure" against a mercury manometer, were made and applied to the results at the completion of each test.

The only details of Method D 417-35T which were not carefully observed were the provisions for a definite amount of outage in the sample container and the air-saturating step. A definite outage was not provided for and the air-saturating step was omitted.

The distillations were run by A.S.T.M. Method D 86-30, with both graduate and flask cooled to about 60° F. before samples were poured into them. Special care was taken to have the distillation thermometer at approximately room temperature before insertion into the flask. Particular care also was taken to record the temperatures for the exact percent condensed points. This was found to be an important requirement. The usual points and, in addition, the five percent condensed point were so treated. In the subsequent determination of evaporated temperatures from the observed condensed temperatures, it was found that the dimensions of the graph paper employed exerted some influence. In the work here reported the distillation chart had the percentage as the abscissae with every percent scaled and with 10 percent to every ¾-inch. The distillation temperature was the ordinate with every 5° F. scaled and with 25° F. to every ½-inch. Distillation curves were drawn with French curves.

Data on 800 samples, selected to cover all seasons of the year and all types of gasolines, were used in this development. Only samples with less than 15 pounds Reid vapor pressure were considered.

DEVELOPMENT

In attempting to estimate vapor pressure from a curve of five percent evaporated temperatures plotted against determined vapor pressures, it was noted that estimations for products of conventional distillation characteristics were reasonably accurate but that estimations for products of unconventional front and distillation characteristics left much to be desired. Estimations on products of abnormally flat or abnormally steep front-end distillation characteristics were either greater or less than the determined vapor pressures, depending upon the nature of the distilla-

[1] Jr. S. A. E., May, 1929.
[2] The Oil and Gas Journal, May 31, 1928.
[3] Blair and Alden, Significance of A.S.T.M. Distillation Curve, Ind. & Eng. Chem., Vol. 25, p. 559, May, 1933.

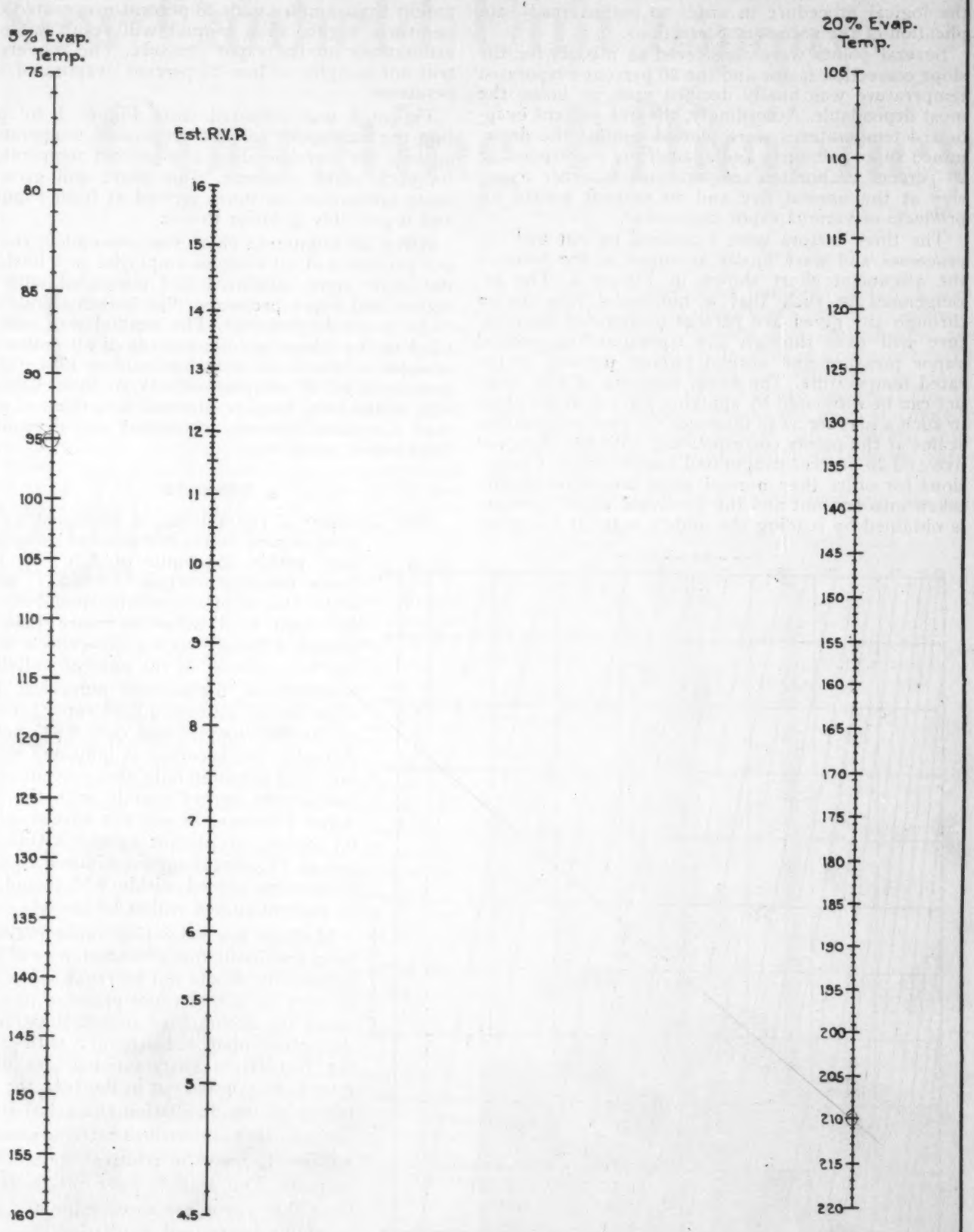


FIG. 1

NOMOGRAPH FOR ESTIMATING REID VAPOR PRESSURE FROM 5 AND 20 PERCENT EVAPORATED TEMPERATURES

tion curve. An alignment chart was decided upon as the logical procedure in order to permit ready application of the necessary corrections.

Several points were considered as a basis for the slope correction factor and the 20 percent evaporated temperature was finally decided upon as being the most dependable. Accordingly, the five percent evaporated temperatures were plotted against the determined vapor pressures and against the corresponding 20 percent evaporated temperatures in order to arrive at the normal five and 20 percent points for products of various vapor pressures.

The three factors were examined by cut and try processes and were finally arranged in the form of the alignment chart shown in Figure 1. The arrangement is such that a horizontal line drawn through any given five percent evaporated temperature will pass through the corresponding normal vapor pressure and normal twenty percent evaporated temperature. The vapor pressure of any product can be estimated by applying a ruler to the chart in such a manner as to intersect the two temperature scales at the points corresponding with the observed five and 20 percent evaporated temperatures. Corrections for other than normal slope are automatically taken into account and the predicted vapor pressure is obtained by reading the middle scale at the point of intersection. From the chart it is immediately apparent that samples with 20 percent evaporated temperatures higher than normal will result in lower estimations for the vapor pressure. The converse is true for samples of low 20 percent evaporated temperatures.

Figure 2 was prepared from Figure 1 by plotting the various 20 percent evaporated temperatures against the corresponding five percent temperatures for each vapor pressure. This chart will give the same estimations as those arrived at from Figure 1 and it probably is easier to use.

After the alignment chart was assembled, the vapor pressures of all samples employed as a basis for the chart were estimated and compared with the determined vapor pressures. The values were found to be in good agreement. The method was next applied to the laboratory file records of all motor fuel samples obtained and examined during 1934. Of approximately 2500 samples, only 17, or about 0.68 percent of the total number, showed deviations of more than 1.0 pound between estimated and determined Reid vapor pressures.

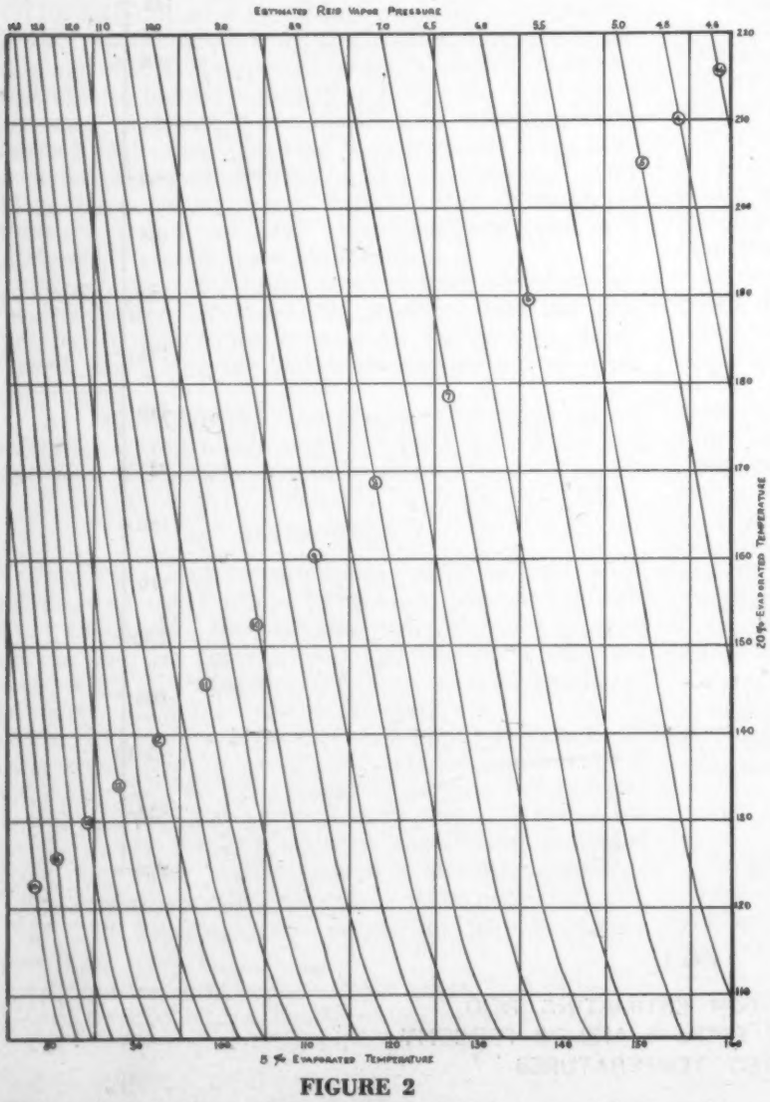


FIGURE 2

Estimated Reid Vapor Pressure determined by use of 5 Percent and 20 Percent Evaporated Temperatures.

RESULTS

The accuracy of estimations, as indicated by the comparisons on the 800 selected samples, is well within the limits of A.S.T.M. Reid vapor pressure method D 323-32T, which states that duplicate results should not differ from each other by more than 0.5 pound. Although such a close check would not be expected in the case of individual comparisons, the average numerical deviation for the estimated Reid vapor pressure of the 800 samples was only 0.325 pound. Actually, the accuracy is indicated by the fact that although only nine percent of the estimations agreed exactly with the Reid vapor pressure, 28 percent agreed within 0.1 pound, 51 percent agreed within 0.25 pound, 79 percent agreed within 0.5 pound, 93 percent agreed within 0.75 pound and 99 percent agreed within 1.0 pound.

Methods for estimating vapor pressures from the distillation characteristics of fuels admittedly should not be regarded as substitutes for actual vapor pressure tests because the accuracy of such estimations is dependent upon the accuracy with which the distillation characteristics are determined. As pointed out in the text, the normality of the distillation characteristics is an important factor since extreme products apparently result in relatively poorer estimations. The authors have reason to believe that vapor pressures estimated from carefully determined distillation characteristics by the method just described may in many cases be superior in accuracy to actual measurements carelessly made. In any event, this independent method of checking vapor pressure determinations should prove to be a valuable tool for use in studies of vapor pressure testing technique.

New Canfield Unit *Improves* Operating Efficiency

CANFIELD OIL COMPANY recently completed a program of modernization at its plant at Coraopolis, Pennsylvania. The first unit in this program consisted of a modern skimming, special products and long residuum processing plant, which was erected early in 1934. A later installation, is the clay percolation unit, which was completed in October, 1935. This company, long in the refining business in Pennsylvania, like all others engaged in the manufacture of Pennsylvania-grade lubricants, was accustomed to shell stills for the preparation of bright stocks and neutrals. Older type of equipment, still standing in some parts of the yard comprise the cheese-box type of stills.

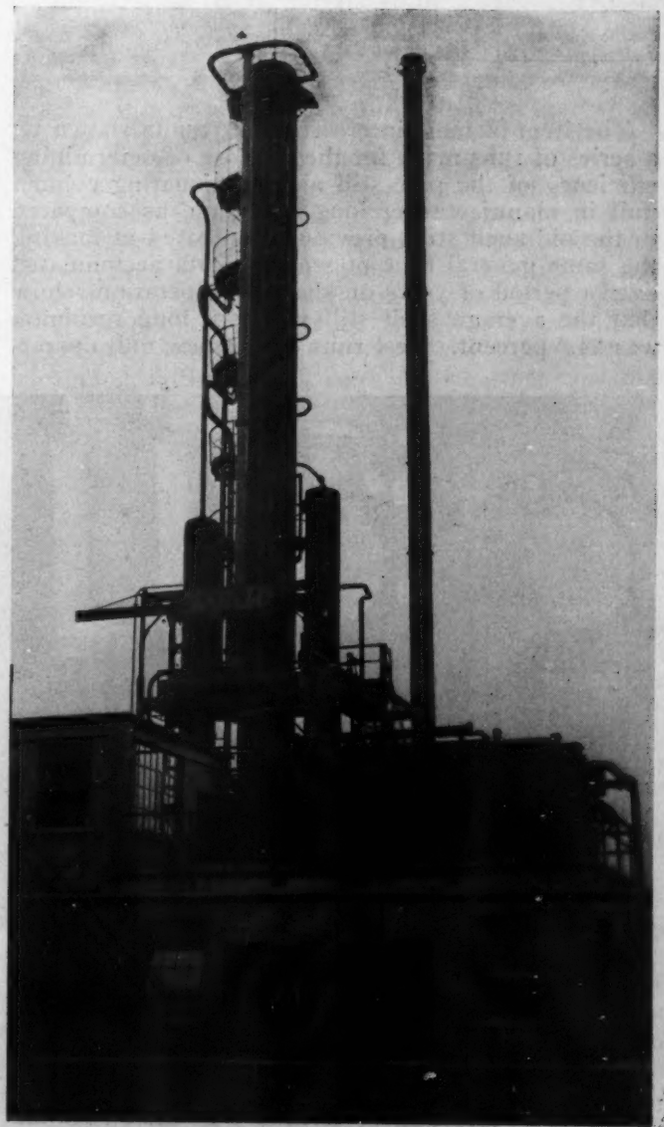
The new unit is of the tube still type, which is becoming common in Pennsylvania, embracing a main fractionating column from which the regular cuts are removed, together with adequate side strippers, and a supplementary column through which a cut may be reprocessed to secure the close-boiling fractions used in the rubber, paint and allied industries. The plant was constructed by Alco Products, Inc., on ground removed from the older units of the refinery. Crude processed through this unit is produced in Southwestern Pennsylvania. It is pumped to the pipe still by the charging pumps, through a series of exchangers.

In order that the plant may process clean, uncontaminated oil the crude is passed through a water drum, after it has passed through the side-cut exchangers. After this it is further heated in the exchangers provided on the gas oil or fuel oil stream and by the tower bottoms through the use of two additional exchangers. It is then admitted to the pipe still, where the temperature is raised sufficiently high that lighter fractions are driven from it in the main fractionating column. The type of furnace used in this plant is so designed that approximately 50 percent of the heating sections are contained in the radiant portion—two rows of radiant tubes, the front being composed of three-inch piping, and the rear of four-inch shielded tubes. Both the oil and vapors generated by the preliminary heating of the oil pass through the pipe still and are admitted to the main column through a six-inch transfer line.

The main column is 99-feet in height by five feet in diameter and contains 48 trays. Forty trays are used for fractionating, while the eight below the tangentially applied nozzle of the crude transfer line are used as stripping trays. Double line connections are applied to the column at points where the side cuts are removed, so that streams of closely regulated characteristics are withdrawn.

The overhead stream of crude gasoline is removed by double connections, at opposite sides of the top of the column, converging immediately into a common line 10 inches in diameter. Each of the primary vapor lines were constructed from six-inch pipe, and the design of the double take-off is to prevent carry-over of heavier fractions by splitting the vapor stream in the upper section of the column. The 10-inch line is continued downward until it connects with the vapor heat exchanger, after which it is reduced to eight-inch before being flanged to the vapor condensers.

The side strippers for the three next cuts are con-



View of unit showing bridle in pipe connections at top of main column.

solidated into a single unit, separated into as many sections as there are fractions to be reprocessed, by blank trays. Exhaust steam from the processing pumps is used in the side stripper sections at a delivery pressure of approximately 14 pounds. Before being admitted to the strippers it is superheated by passing through a special coil bank placed in the convection section of the pipe-still furnace.

An analysis of the various streams removed from the main column in this unit is as follows:

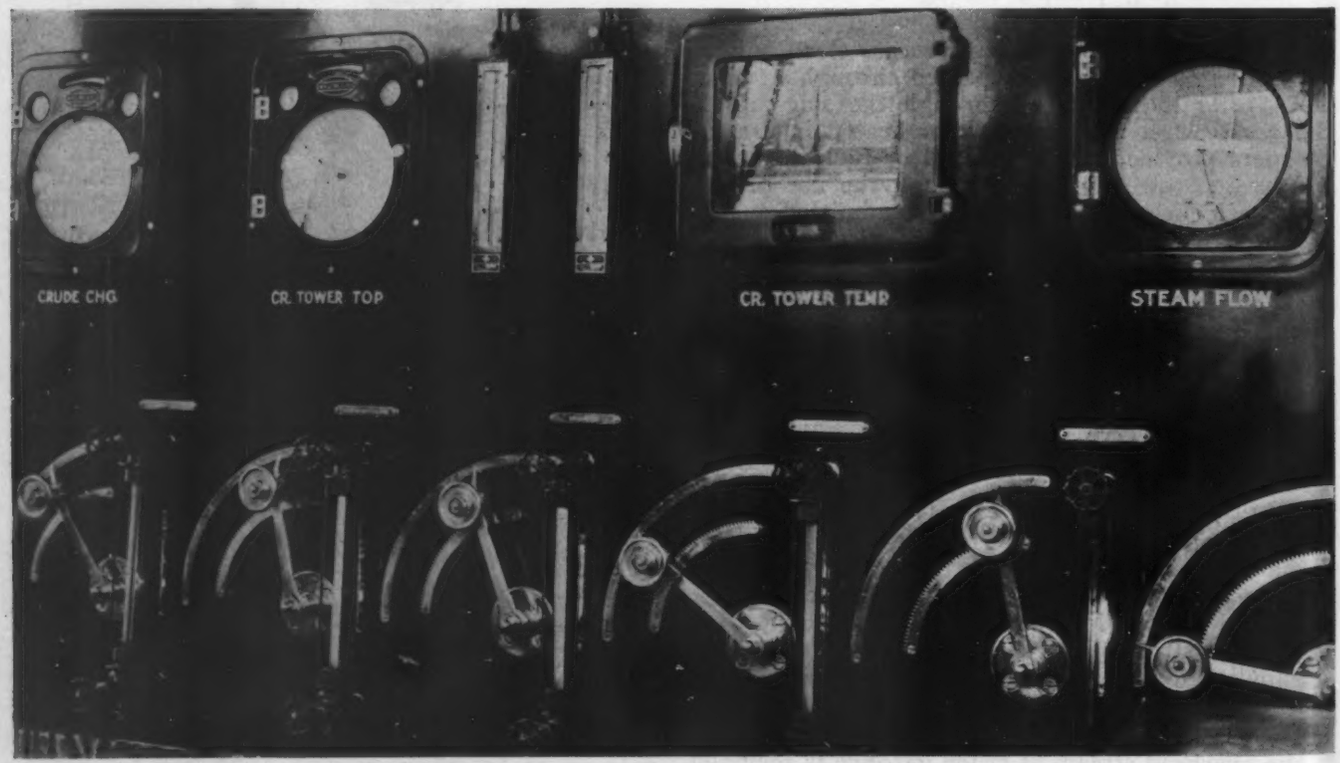
	Crude Gasoline	Solvent	Kerosene	'300' Oil	Gas Oil	Long Resid. Bottoms
Gravity, ° A.P.I.	66.4	53.2	47	40.7	37.3	28.4
I. B. P., ° F.	99	311	391	509	550	...
10 percent	161	320	407	533	612	...
20 percent	185	323	415	541	629	...
30 percent	203	325	424	548	640	...
40 percent	217	327	430	555	649	...
50 percent	230	332	438	560	655	...
60 percent	240	335	443	563	660	...
70 percent	255	340	460	576	668	...
80 percent	269	345	475	585	675	...
90 percent	289	355	503	600	687	...
95 percent	305	369	530	620	700	...
E. P., ° F.	330	387	545	635	715	...
Residue, percent	0.5	1.0	1.5	1.	2.5	...
Loss, percent	1.5	0.5	0.0	0.	0.0	...
Flash. Tag. CC ° F.	...	105	...	...	...	...
Vis. at 100° F.	...	...	...	41	55	...
Vis. at 210° F.	...	...	...	...	...	83
Flash, ° F.	...	...	...	280	...	470
Fire, ° F.	...	...	...	300	...	530
Cloud, ° F.	...	...	...	24	...	...
Pour, ° F.	...	...	...	20	50	85
Octane Number	50	...	...	...	...	...
Yields, percent	25.2	8.3	19.3	11.2	10.9	25.6

The item of most interest is the results shown by a series of runs made for the purpose of determining efficiency of the pipe still and fractionating column unit in manufacturing long residuum, as compared to the old shell stills previously operated in making the same general type of stocks. Data accumulated over a period of years on shell still operations show that the average shell still yields of long residuum was 24.2 percent. Test runs on the new unit operating on approximately the same class of crude charge, show that a yield of 25.6 percent is obtained. The increase in long residuum is 1.4 percent, in favor of the pipe still plant based on crude charge, but when compared to net results, expressed in long residuum, the increase is approximately six precent over the shell still battery.

Because of the increased efficiency of the new unit, as compared to the more or less obsolete type of equipment operated generally throughout the lubricating manufacturing field in preliminary distillation and process work, the owners concluded that it would be better business to modernize the entire plant. The erection of a new filter plant was the next step in the program and this has been justified by showing that 10 of the modern percolation type filters can do as much in a given time as 20 did when operating the older type.

Because of the desire to operate for better efficiency, the crude gasoline is re-run through the special column erected in conjunction with the new pipe still unit. Tests show that the octane value of the re-run gasoline averages better than 66, which places the product on a basis of suitable material for motor fuel to be used in the more modern automobile. The crude gasoline, taken directly from the main fractionating column, and having an end-point of 330° F., has an octane value of only 50. The lower the end-point of Pennsylvania gasoline, the higher the octane rating, and by cutting the end of the gasoline to approximately 250° F. a better product is obtained.

The special column, having 30 bubble trays, is also used to manufacture special solvents in addition to the low end-point motor fuel. Naphthas designated as super-naphtha and as naphtha-B are obtained, the first having a boiling range of about 58 degrees between the initial boiling point and the 95 per cent point, while the naphtha-B has a shorter range; being only about 48 degrees between the same points.



Control Board, Canfield Oil Company, Coraopolis, Pennsylvania

Metallizing *In* Industry

H. R. LELAND
General Metallizing Company

THE art of applying a thin coating of molten metals to a surface, whether that surface is another metal, or some other substance, such as stone, concrete, leather or any other article has been greatly improved upon since the first experiment was made in the process about 25 years ago. A Dr. Shoop, of Zurich, Switzerland, worked out a very complicated device at that time for spraying metals as a coating for other substances, particularly other metals used in the various industries of Europe where corrosion, erosion and other forms of wear were encountered while the articles were in use.

Spraying molten metal, or what proper term may be used in describing the process, has been and is being used extensively, not only in refineries and gasoline plants on the Pacific Coast, in the Mid-Continent and Eastern fields of the United States, but in many other industries, to prevent corrosion and retard wear of the metals used in machinery.

The process of spraying molten metals is simply a method of applying a thin coating of any of the metals which may be melted, and which is suitable for the particular purpose, to a properly cleaned and roughened surface. Fusing of the two metals, the sprayed one and the surface upon which it is being deposited, is not the object sought for and is consequently not obtained. Bonding of the two metals is the object desired, and when the surface of the interior of the vessel, or the exterior surface of shafting, plungers, pistons and the like have been properly prepared, the bonding of the two metals is obtained with such tenacious sticking qualities that a separation of the two is difficult, if not impossible.

In a paper by B. E. Embry, of Southern California Gas Company in Los Angeles, and read before the Technical Division of the Pacific Coast Gas Association, the process was defined as follows:

"Metal spraying is exactly what the name implies —the spraying of molten metal on practically any object, such as glass, wood, steel, paper, cement and various other substances. The metal so deposited has the same characteristics as the original metal. In other words, these metal coatings can be ground, machined, polished, or treated in practically any way that the parent metal itself can be treated.

"The success of metal spraying is dependent to a large extent upon the proper treatment of the material—metal or other surface—before the metal is applied. Porous material such as plaster, cement and wood, require no preparation other than the removal of all oil, pitch or grease. The non-porous articles, such as glass, steel, iron, etc., require a preliminary sand blasting before coating. This forms minute indentations of the material so that the metal to be applied when in its molten form, can secure a good bond. As soon as the surface metal is sand blasted it should be coated immediately, for if it is allowed to stand, it will collect moisture and dust, and thereby impair the bond."

Preparation of the surface to be coated is stressed considerably, especially by engineers who are using metallizing guns in refinery protection. It is not only necessary to thoroughly clean the surface to be coated, but it is also necessary to roughen up the surface. To get this roughness, it is necessary to employ a good grade of angular blasting sand made from quartz or flint rock. The idea is to raise the "nap" on the surface sufficiently that the sprayed metal will adhere with a tenacious bond. One engineer suggests that if the surface being sand blasted be rubbed with a pair of mule skin leather lined gloves, the glove fibres will cause a yellow streak to appear across the metal, caused by the minute "hairs" dragging on the leather. And, if the surface is rubbed in this manner, and no fibres appear to be pulled from the leather gloves, the surface is in no condition to receive the metallized coating.

Merely spraying molten metals haphazardly upon a surface is not a cure-all for refinery corrosion by any means. If aluminum is applied to the interior of a vessel which is to be used in caustic service, the results will, naturally, be sadly disappointing. But on the other hand, if the aluminum is deposited on the interior of reaction chambers and the like, which are being disintegrated by corrosion resulting from hydrogen sulfide, the results will be the opposite; satisfactory to a degree not generally expected by many engineers who are not entirely familiar with the process and the action of corrosive acids upon the surface of metals.

The first thing a refinery executive should do when contemplating the use of a metal spray gun, is to make it possible for some employee within the organization to become thoroughly familiar with the process. The man selected to head the spraying force should be a practical mechanic, one who is familiar with metals to a certain extent, and the effects upon metals when they are exposed to the corrosive influence exerted by various gases and liquids encountered in refining petroleum. Not all men will make satisfactory operators as past experience has proven. A man who will develop into the best metal

sprayer need not necessarily be one who is a trained engineer, but such a man will make an excellent operator if he is equipped with an open mind, not biased by predetermined ideas.

The man should be equipped with a mind capable of grasping ideas above the average, but above all, he must be a man who is conscientious and does not slight or slip over any detail concerning the job in hand. There are many men in every organization who are not particularly working from five o'clock to pay day who will make good spray-gun operators. The one selected should be given every opportunity to become familiar with the process, the guns used, the sand blasting machinery, the adaptability of metals and the use and care of equipment. One of the most disastrous mistakes a company can make with metal spraying is in the selection of a man who is not equipped with a mind and dexterity of hands above the average run of yard workers, and who is subsequently expected to operate the spray gun in the yard or the machine shop of the refinery.

The preliminary, or superficial sand blasting should be done in such manner that all the closely adhering coke and oxides or sulfides can be thoroughly removed from the surfaces. This operation may be carried out with ordinary river, or sand bank sand which is ordinarily used in cleaning other equipment preparatory to painting or salvaging. There is a great difference in sand blasting material, so much in fact, that as ordinary river sand is useful in cleaning a surface, it is unfitted for preparing a bonding surface for the sprayed metals to adhere to. After cleaning the surface with the cheaper preliminary sand blasting material, all seams, welds, rivited connections and the like should be rigidly inspected. If any breaks or openings appear after the surface is cleaned, they should be repaired before the secondary sand blasting is begun. If oil appears to be soaked into the porous welds or seams, or in fact into any part of the vessel, it should be drawn out with a torch and removed by sand blasting. If permitted to remain in place, the sprayed metal covering these places will eventually blister and perhaps peel from the surface. Formation of gas by heating the oil which remains in the metal will push up the thin coating and cause unsatisfactory performance. Undoubtedly the presence of oil and improperly prepared surfaces has contributed more to the blistering

Interior of a Dubbs reaction chamber, 10x40 feet, Phillips Petroleum Company, Kansas City, is being spread with molten aluminum to prevent corrosion due to hydrogen sulfide.

Pump piston which has been ground to a finished polish after being treated with sprayed molten metal.

of sprayed metal than any other factor met with in refineries.

If coke adhering to the walls of the chambers is so hard and firmly bonded that removing by sand blasting is a tedious and long drawn out process, the surface may be cleaned by burning. Extreme care should be exercised when doing this so the temperature will not exceed about 900°F. A suitable burning torch may be placed in the lower section of the vessel or column and thermocouples placed at various points to determine the temperature at any given point while operating the coke burning equipment. If cracks are found in the walls after cleaning out the coke in this manner, naturally they should be repaired before the secondary sand blasting is begun.

Sufficient air must be made available for the operators so that dust and fine coke may be removed as it is being blasted from the surface of the columns. A forced draft of air, preferably entering at the top, or upper manhole and evacuated from the bottom connections, running at about 90 lineal feet per minute, is usually sufficient to clear the chamber. Men who are operating the sand blasting guns and equipment, as well as the spray guns, should be equipped with approved safety breathing masks with fresh air being constantly fed to the face pieces while the operators are inside the vessels.

The secondary sand blast which should follow immediately after the preliminary cleaning with sand, is accomplished with the same machinery used in the first operation. A change in grit must be made, because in the first place, ordinary cleaning sand is not angular enough in the grains to penetrate into the metal sufficiently far to prepare the surface for spraying. In the second place, about 30 percent of the sand goes to dust while sand blasting which is useless of course, for any purpose, even cleaning. The type of sand blasting material which has given excellent results in the Mid-Continent fields is prepared from rock removed from the lead and zinc mines of the Tri-state area of Southeastern Kansas, Southwestern Missouri and Northeastern Oklahoma. It is known as No. 4 Joplin chat, and is sharp and angular enough to prepare the surface by raising the "nap" of the metal for a firm and lasting bond.

The procedure generally adopted by sand blasting operators, is to begin with the secondary blasting at the top of the vessel and blast about 100 square feet, then begin spraying. If all the surface of the interior, of say a Dubbs 10 by 40-foot reaction chamber is blasted in one operation, the surface will become more or less oxidized which will prevent the desired bonding of the sprayed metal to the interior of the chamber. Two men, trained in sand blasting are usually employed, one of whom operates the sand blasting nozzle while the other man operates the sand machine and sees that a supply of material is always available.

Both these men operating the sand blasting equipment are perhaps the men who have been trained to operate the spraying guns, know how to adjust the flame to the neutral point, adjust the air pressure for forcibly projecting the molten metal to the properly prepared surface. If they have been selected for their native ability and trained as they should have been, they will encounter no difficulty in proceeding with their duties. The success or failure of metal spraying hinges upon the proper preparation of the surface of the metal to be covered, and the ability of the spray-gun operators to get the proper degree of fineness in spraying. The fineness of the sprayed metal has a great deal to do with the ultimate lasting qualities of the coat. Metals can be sprayed with relative large globules of molten metal leaving the tip of the gun, and when striking the roughened surface, form miniature patches on the surface. If these globules are atomized, as it were by breaking these globules up into many smaller ones, the coat becomes denser and has a finer grain structure.

When aluminum, for instance, is applied to the interior of reaction chambers or dephlegmators, the operators change from sand blasting immediately after the usual 100 square feet have been cleaned and the "nap" of the metal raised. The freshly sand blasted surface of iron or steel oxidizes quite rapidly, depending upon the weather and the relative humidity of the air within the chambers. This film of iron oxide may not be visible to the naked eye, but a slight change from a fresh, cleaned iron surface to one even slightly oxidized may result in an improper and unsatisfactory bond. The operators of spray guns develop a technique all of their own; some cover the surface in rectangular areas, lapping the spray, while others cover a surface with a light coat-

ing and finish afterward. The surface covered is usually said to contain ten coats, which is an outgrowth of the original method of covering lightly with one coat after another. When metal spraying was in the experimental stage, the operators were timed and trained to operate the equipment with a uniform motion. Since important improvements have been made in the guns, the metal is projected with greater rapidity, so each operator must use his own judgment in applying the coatings.

Some operators swing the guns in a horizontal direction, lapping the ribbons of sprayed metal, so that when he has covered the designated area, the operation is completed. The object is to apply the molten metal to the surface in such a manner that the desired thickness is obtained as well as a uniform mechanically plated surface. By adjusting the flame, which melts the wire, and the force of the air blast, the fineness of the sprayed metal can be regulated so that it presents a homogeneous mass, not subject to pores or other irregularities. The resulting fine grained surface and body of the metal coating prevents the intrusion of corrosive acids and gases. The results desired can be only obtained by selecting the proper operators, and then training them so that they become proficient, as well as exercising the essential judgment necessary to produce results.

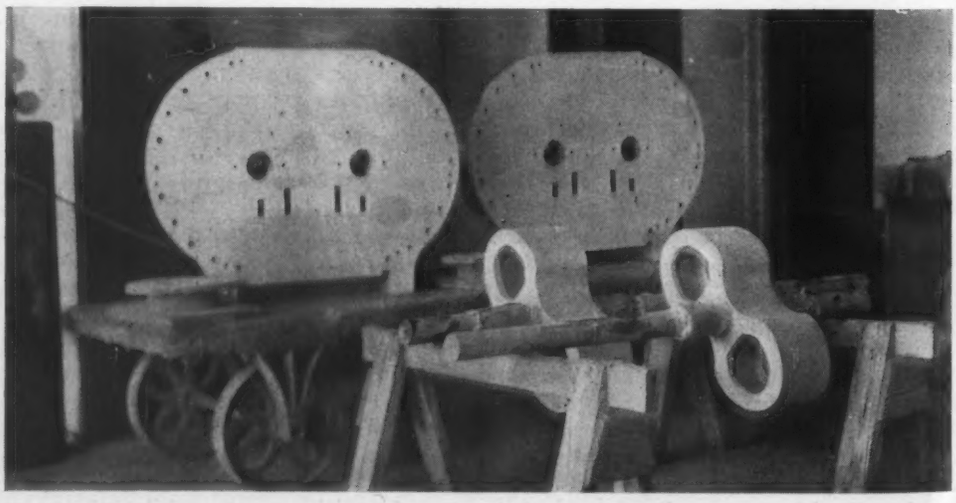
When shafts are to be built up, or pistons of pumps and engines, shafting of centrifugal pumps and the like, a different procedure is followed. The shaft or plunger is treated to a rough cut the full length of the area which is to be covered. Some engineers use a tool which cuts a standard V thread with as rough a surface as is possible to obtain, sometimes allowing the tool to chatter slightly, which further roughens the surface. Other engineers advocate the use of tools which cut a square thread and afterwards substituting the standard pointed tool which cuts a V thread in the top of the square one. Various numbers of threads-per-inch are advocated, but good results can be obtained with about 12 per inch. Sand blasting is usually followed so that the surface of the piston or rod is roughened beyond the threaded portion to preclude the possibility of the metal curling when deposited upon a polished and oily surface.

The surface of the rod, piston or plunger may be covered by spraying the molten metal from any alloy wire desired, and which is adaptable for the resistance of corrosion or wear encountered in service. High carbon steel and chrome nickel are used extensively to cover various types of rods and shafts. Many hot oil plungers used in high pressure service in refineries where corrosion is such that the metal is removed rapidly, and the packing torn out rapidly, have been sprayed with 1.2 carbon after properly preparing the surface. The completed shaft is then placed in the usual machine and ground to the original outside diameter.

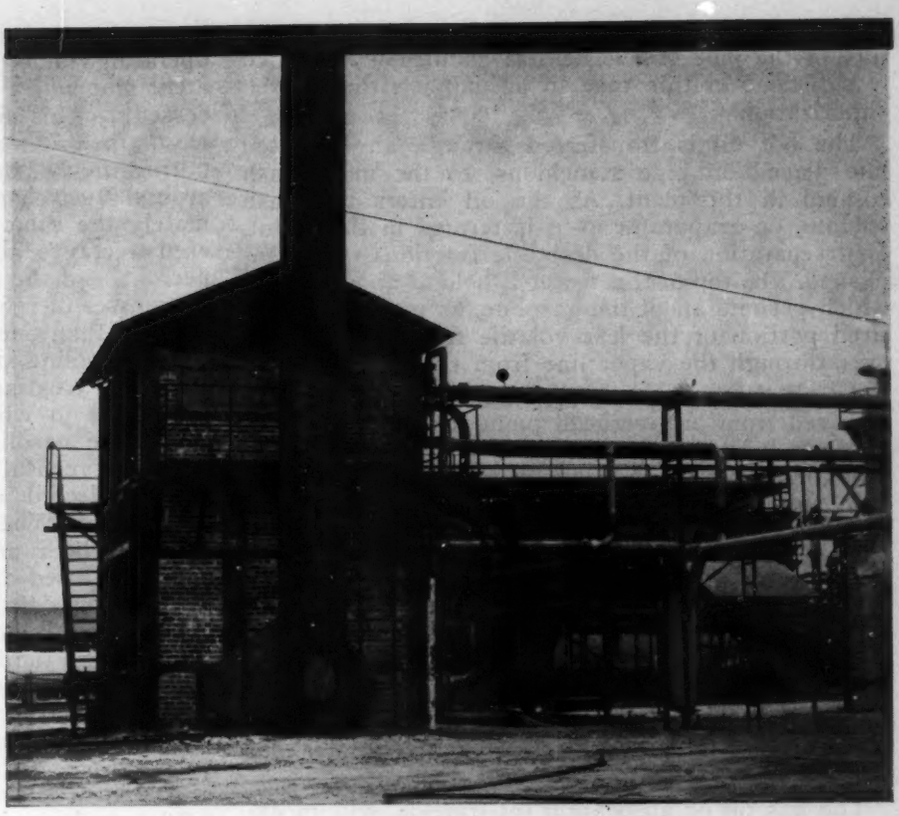
When actually covering the worn portions of the article under repair, it is placed in a lathe and centered in the usual manner. The gun with the proper adjustment for this class of work is mounted on the tool post of the lathe, with the tip directed toward the shaft mounted in the lathe. With the machinery in motion, the metal spray is directed to the shaft in a continuous stream, traveling slowly along the shaft until the other end is reached. If an insufficient amount of metal has been built up, the process is repeated.

One of the first test applications of sprayed aluminum on the interior surface of a Dubbs reaction chamber was put on at West Tulsa. Test sections were selected, one being in the upper head and one about 15 feet below on the side walls and covering a seam. These patches were selected because the upper one was where the most active corrosion was being experienced from hydrogen sulfide, and the lower because it was located where the clean-out gang attacked the walls most actively with their picks. After the applications were made, the area not so covered was protected in the usual manner, employing ganister which was extended over the sprayed aluminum just enough to cover the edges.

The cracking operation was carried out so the residuum resulted in coke, which placed a severe test upon the lining. After five months had elapsed after the coating was sprayed on, an inspection was made of the chamber and the aluminum patches. The coke was removed in the usual manner, and after the cable had been pulled, picks were used to remove the hard shell adhering to the lining and the test areas. An examination of these test areas showed that they were intact and closely adhering to the steel. A few small spots showed where the aluminum had come from the steel, but the total amount did not exceed one-fourth of one percent.



Rotary blower disassembled and treated with molten metal, sprayed upon its parts to prevent corrosion.



New Pipe Still at The Norwalk Company's Maricopa, California refinery.

Improvements Aid Norwalk Plant

THE Norwalk Company, operating a refinery at Walco, near Maricopa, California, realizes a distillate yield of 31.7 percent of 410°F. end-point straight-run gasoline when processing a 27.3 A. P. I. gravity Univistas crude. The refinery as it now stands is an outgrowth of a small distillation unit erected several years ago, but as time went on and requirements of the refinery changed, refinements and additions were built.

The company recently erected a new pipe still to supersede an old unit which had been in service several years, and which has added greatly to the efficiency of the plant as a whole. The heater was designed by Foster-Wheeler Corporation and was placed in operation about the first of February, 1935. The two gas burners serving the pipe still setting were placed in the front end of the pipe still combustion chamber.

Pre-distillation, topping or stabilizing of the crude is accomplished in this plant by utilizing hot residuum from the flash column to heat the incoming fresh crude so that a considerable percentage of the light fractions can be removed before the crude enters the pipe still tubes. Counter current flow is employed by using several tube and shell exchangers, securing a temperature of about 265°F. on the charge. After passing through these exchangers, the hot crude enters a preliminary flash column where the tops are removed. The vapors resulting from this flashing operation are either passed directly to the atmospheric condenser sections, or are thrown together with the vapors from the main flash column. This operation depends upon whether or not the distillate is sour. If it needs treating, it is condensed with the bulk of the overhead distillate, but if sweet, it is condensed separately and used for various purposes. When condensed and accumulated separately, it has been found that about 10 percent of the crude can be taken off in this manner.

After the crude has been treated in this preliminary operation, it is again pumped but this time it is directed to the new pipe still. Pressures throughout the plant are not high, the most pressure encountered in the plant at any one place is at the outlet, or discharge of the hot oil charging pump which is maintained at about 55 pounds to secure the

proper velocity through the tubes. The temperature of the pipe still is held at about 480°F., which is sufficient in this case to accomplish the desired vaporization.

The hot oil is transferred through an insulated line placed on pipe stanchions, to the main flash column in the plant. As the oil enters the flash column, or evaporator as it is termed in this plant, final separation of the desirable fractions is accomplished. The top of this tower is held at about 425°F. which permits all of the gasoline, as well as the desired portion of the less volatile fractions to come over through the vapor line from the topped crude.

As all the vaporized fractions of the charge are removed from an overhead point in the evaporator, they are led through a vapor line to the main fractionator. Several cuts may be taken from this column simultaneously, but ordinarily only two fractions are manufactured. Gasoline having a gravity of about 50.5° A. P. I. is taken from the overhead while gas oil having a gravity of about 35.5° A. P. I. is removed from the bottom. When it is desired, the gas oil may be lowered both in percentage and gravity. At times, an absorption oil is manufactured direct from the fractionating column. When this is done, refluxing is resorted to in such a manner that the end point of the product is maintained at about 485°F., and the gravity at 35° A. P. I.

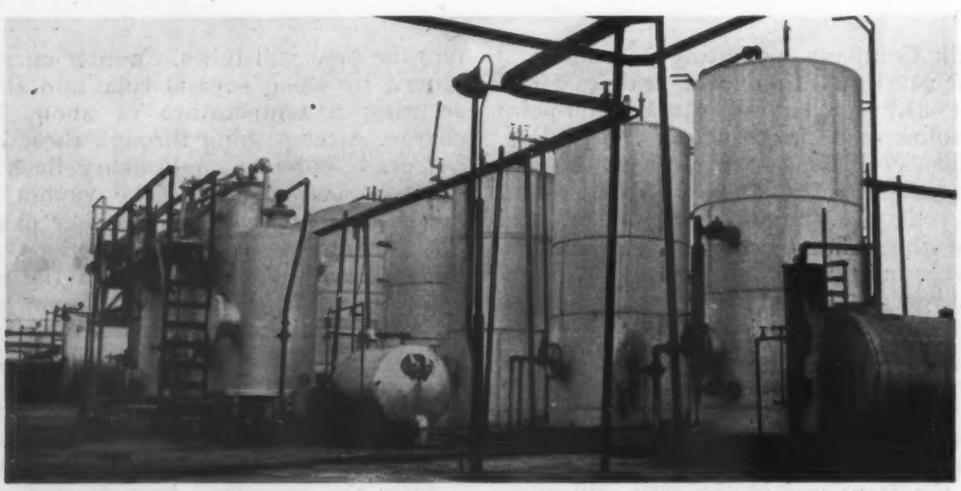
The gas oil or absorption oil fraction seldom exceeds two per cent of the total charge, but this amount varies as to the quality of the distillate. A Diesel fuel also is manufactured directly from the column when market demands require it. As the evaporator column is operated with a low pressure, about 4½ pounds gauge, the residuum is pumped from the base through the preliminary heat exchangers after which it is directed to storage. The gravity of this product averages about 18.5 degrees A. P. I., and the percentage recovered runs around 68.2

The usual amount of crude charged averages about 3200 barrels daily, but a larger amount could be processed. During February, 1935, the plant was operating under the Pacific Coast Agency Agreement and had a quota which kept the amount processed to this figure. The charge to the plant is maintained at a uniform rate, varying only slightly during the 24 hours of the day. Each shift processes around 1080 barrels, and the yields are approximately the same for each stillman. Gasoline recovered averages about 32 percent, gas oil about 1.5 percent, and the fuel oil bottoms about 68.5 percent. The losses of refining are exceptionally low, averaging less than one percent.

The gasoline manufactured at this plant is a trifle sour, and treating is accomplished with a combination plant in which caustic, chlorine and acid are used. The gasoline is contacted with caustic in a series of vertical columns, after which liquid chlorine is injected into a treating column designed for this purpose. The chlorine is purchased in large containers which are laid down beside the treating plant and used as the occasion demands. The chlorine is vented from the containers through a small rubber tube, which is attached to both the drum of chlorine and the line leading to the treating column. Only the necessary pressure required to force the chlorine through the tube to the gasoline is maintained on the rubber tube. An average treat requires about 7/100 pounds of chlorine to the barrel of gasoline. Caustic is consumed at the rate of about 2/10 pound per barrel, and final acid treatment requires about 15/100 pound per barrel of gasoline.

Gasoline is shipped both by truck and tank cars from the loading racks in this plant to various points in California. Gasoline is gauged into the tanks and tank cars in addition to measurement through meters which are used as a check on the amount shipped.

Vapors not condensed in the distillate condensing and cooling sections are taken from the various points in the plant through vapor lines connected to the company's gasoline plant situated nearby. The gasoline made by this plant is used both for blending the distillate to the required gravity and volatility and shipment to other points.



Continuous Systems for Treating With Caustic, Hypochlorite and Sulfuric Acid.

Vacuum Unit *for Lube Distillate*

GOLDEN BEAR OIL COMPANY, LTD., at its 500-barrel refinery near Bakersfield, California, processes company-owned crude production from Coffee Canyon field for yields of lubricating oil distillates. The crude is about 15 A.P.I. gravity, wax free, contains no gasoline, but has a large yield of gas oil and lube distillate.

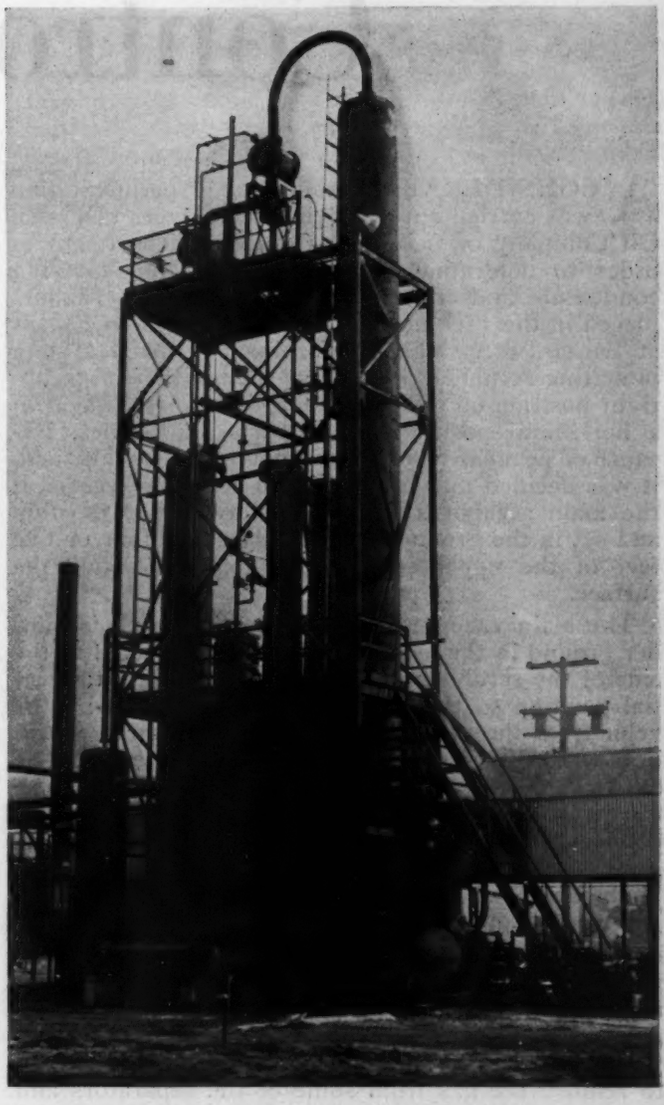
The oil is charged to the plant by a duplex reciprocating steam-driven pump, passing through a bottoms-to-charge exchanger to a preheating retort. In the exchanger it is heated to about 375° F., which temperature is sufficient to secure precipitation of the salt and desired dehydration. A second pump charges crude from the salt settler and dehydrator to the tube still where the temperature is increased to about 700° F. It is flashed into a vertical chamber where a 26 A.P.I. gas oil fraction is removed at atmospheric pressure. A more or less conventional column is used for this purpose. The bottoms from the tower are then pumped to the main fractionating column for separation of the lubricating oil distillate.

This column is equipped with steam vacuum jets which hold about 28 inches vacuum on the tower. The overhead cut removed by this means at a temperature of about 410° F. is a non-viscous neutral oil. It is automatically removed from the column through a float-controlled valve which allows the liquid to flow to a pump set near the base of the column. The pump discharges through coolers and to storage. The middle cut, or medium lubricating-oil distillate is removed from a blind plate in the column at a temperature of about 510° F. This condensate also flows through a liquid-level control to a pump discharging through coolers.

The third cut is removed in a like manner, and is termed "heavy" lubricating oil distillate. Bottoms from the column are converted in the process by the injection of sufficient process steam to form asphalt with penetration of about 180. This material is not finished at the plant but is shipped to other processors to be converted into various asphalt products. The quantity of the three distillate products of the main fracionating column varies according to the weight and viscosity desired, the amount of vacuum applied to the column and the amount of process steam used in the base of the tower.

All of the products, except the asphaltic material, have a very light golden color with a greenish cast. The viscosity varies from 500 to 900 seconds at 100° F. and for the heavy fraction, from 1500 to 5000 seconds; depending upon the market requirements.

None of the lubricating oils are finished at the Bakersfield plant, but are shipped to Master Lubricants, a subsidiary concern at Los Angeles, where they are acid treated and give contact clay treatment. This consists of treatment with sulphuric acid, followed by mixture with finely ground native California clay and circulation through a pipe still and tank. When the desired temperature is reached in this operation, and after standing at temperature for a short time, the mixture of oil and clay passes to filter presses and the oil is extracted. The clay is discarded after one pass through the cycle.



Golden Bear Oil Company's plant at Bakersfield, California, which is used in processing heavy Coffey Canyon crude in the manufacture of lube distillate.

Novel and Efficient

Scrubber Control System

A CONSIDERABLE amount of experimentation was carried out by various employees of Union Oil Company of California's gasoline department in order to determine the best method of removing condensate and crude oil from the intake scrubbers placed in the vacuum lines at the Bell gasoline plant at Santa Fe Springs, California. The usual system of setting scrubbers is to place them either in an upright position on concrete slabs, or to install them in a horizontal position on supports, or cradles. Because of peculiar conditions encountered in this field, it was decided that better results could be secured if the main scrubbers were set in a vertical position and set in the ground so that only about four or five feet of the upper section was exposed above the surface.

The main vacuum, or gathering line is placed under ground in the usual manner and connected to the side of the scrubber with fittings placed in a tangential position so that centrifugal force caused by the velocity of the gas would insure satisfactory separation of the fluid from the gas being processed. The outlet of these particular scrubbers was placed in the top head and because of the distance of the upper connection from the surface of the ground, a short riser serves to connect it to the plant header leading to the compressors.

When the field was new these usual type of liquid level controllers were placed on the scrubbers to remove the liquid, because the gathering system always had a pressure considerably above atmosphere. As production pressures declined and the wells were pumped, a varying amount of vacuum was necessary to remove the gas from some of the separators and flow traps. This situation caused the liquid level controls in use to become unfitted for the service.

The older type of drip service required only the setting of the liquid level controllers on the surface of the ground, but when the change was made, it was necessary to excavate beside the scrubbers to a point below the base. This excavation, walled with cement, was large enough for an employee to descend on a permanent ladder placed in the wall of the controller pit. An auxiliary drip was made which was designed with sufficient capacity to handle the oil and condensate and placed below the level of the lower end of the scrubber. The drip was connected to the scrubber in the usual manner, having a check, gate and equalizer line. A fluid discharge line was connected to the end of the drip opposite the one connected to the scrubber, and was built with a double line near the outlet.

On each of these lines a remote-controlled diaphragm valve was placed set to function when the drip became filled with liquid. Two additional controllers were placed on gas pressure lines leading to the drip, which open coincidentally with the opening of the discharge line controllers. Another pair of controllers was placed on the outlet line leading from the scrubber to the drip which closed as the other two controllers were opening. When they were synchronized, the supply line leading from the scrubber to the drip was closed at the same time the outlet, or bleeder line was opened and at the same time, gas pressure was applied through the third set of controllers which forced the oil and pipe line condensate from the drip to plant drains, or to storage tanks for subsequent treatment.

These controllers were taken from idle plant stocks and placed in service by plant employees who were responsible for the design of the apparatus. In setting the controllers, they were placed in pairs for a protective purpose. The first set was calibrated so that they would function before the others, and when and if they failed to open as required, the second set would begin to operate so as to prevent the scrubber becoming filled with drips and overflow into the intake of the compressors.

In addition to the double set of drain controllers, a recorder was placed in the assemble to make a record of the number of times the drips were opened, and to record the duration of the individual flow. As a further means of protecting the compressors from fluid, an electrically operated switch was set in line with the action of the liquid level apparatus which would close a circuit when the fluid level in the scrubber reached a certain predetermined height. This circuit was placed so that it would operate the signal horns and red lights placed in the main engine room. This signal device was tied in with other signal circuits used in different parts of the plant, and informs the operators of the trouble and points out the definite location as well.

After the system was installed and adjusted so that each valve would function in proper time with the others, very little difficulty has been reported. H. P. Rissinger, plant supervisor at the Bell gasoline plant is responsible for the design of this equipment.

Carbon-Dioxide Recorder And Its Use

HENRY COONEY

NO INVESTMENT in power-plant equipment, it is believed, will pay a higher rate of interest than a properly used carbon-dioxide recorder. If this apparatus is to be intelligently used by the boiler operator, it is evident that he should keep himself informed as to the percentage of CO_2 the fuel burned will produce when just the correct amount of air is supplied for combustion. Given this factor, the maximum or ultimate (as the term is usually called) CO_2, simple calculations, tables or graphs will supply the information needed to keep the combustion efficiency at a high point.

This ultimate CO_2 factor is usually calculated from combustion analyses of the fuel, or orsat tests of the products of combustion, or, it may be closely approximated from the readings from the recorder. Only gaseous fuels are here considered, yet liquid fuels are subject to similar relations.

Consider a case where natural gas is used as the fuel. Should a combustion analysis of the gas give 86 percent methane and 14 percent ethane, the calculated ultimate CO_2 would be 12 percent. In checking this result by an orsat analysis care should be taken to secure a sample that does not contain carbon monoxide, as the presence of this gas may indicate unburned gases other than the carbon monoxide itself. Further, the calculation will be simplified. An orsat test showing 10.0 percent carbon dioxide and 3.5 percent oxygen, or any percentages of these gases in the proportions given by a true test will answer. Substituting these values in equation No. 1 and solving, the result is 12.0 percent as before.

Equation No. 1

$$\text{Ulti. } CO_2\ \% = \frac{20.91 \times \%\ CO_2 \text{ from recorder}}{20.91 - \%\ O_2 \text{ from recorder}}$$

In checking with the recorder for this ultimate CO_2 factor, it is assumed that the instrument is showing 10.0 percent. If reducing the supply of air to the furnace causes this percentage to increase, it is evident that too much air is being used. Continue reducing the air supply until a drop in the reading of the recorder is noted. The highest percentage recorded will be near the correct ultimate CO_2 value.

Table No. 1 is designed to aid in interpreting the readings of the CO_2 recorder when the gas is of the composition indicated. The table is based on the assumption that the hydrogen in the gas will burn to water vapor, as it usually does, and that a considerable percentage of carbon monoxide may be produced without a portion of the gas escaping unburned. This latter assumption will not as a rule hold in practice, as those who have tried firing an ordinary boiler with a reducing flame are well aware.

Referring to the table, it will be noted that when the recorder reading is 11.0 percent, the flue gases may contain 1.74 percent oxygen, or 1.23 percent carbon monoxide. If a CO recorder were used in conjunction with the CO_2 instrument, or if an orsat test were made at this time we would know which side of the combustion equilibrium we were on. But as we are supposed to be firing without these "conveniences," the proper procedure is to try the air as suggested above, or the gas supply, in order to bring the CO_2 reading as near 12.0 percent as possible. If this "ideal" percentage is not desired, the addition of air after this adjustment will reduce the reading to 11.0 or whatever percentage is desired. The operator now has the satisfaction of knowing that the fires are now on the oxygen side of the combustion equilibrium. However, it should be remembered that when the recorder is showing 12.0 percent the amount of air or unburned gases leaving the stack is negligible.

Since modern furnaces will withstand the heat of the perfect combustion of natural gas, and since we have burner equipment which will produce such combustion, it would seem that the claim that 15 or 20 percent excess air should be used in burning this fuel no longer holds.

In support of this claim attention is called to an inert gas producer now being used in the industry, which generates a gas (from any gas suitable for domestic consumption) containing less than 1.0 percent of oxygen and less than zero percent carbon monoxide—practically pure nitrogen and carbon dioxide. This gas, it is claimed, may be inhaled in large volumes without irritation, so it must be free from hydrocarbons. The CO_2 content of this varied but 0.4 of 1 percent in a three-day trial run. This generator's chief advantage over the ordinary steam generating outfit is the fact that it has a constant load. It has been stated that variable steam loads may be rendered fairly constant by study.

TABLE 1

Changes in the Percentages of the Volumes of Flue Gas for Varying Percentages of CO_2

CO_2 from Recorder Percent	CO Percent	O_2 Percent	N_2 Percent	Air Excess Percent	Air Deficiency of Percent
8.0	0.0	6.96	85.04	44.9	0.0
9.0	0.0	5.23	85.77	30.0	0.0
10.0	0.0	3.48	86.52	18.0	0.0
11.0	0.0	1.74	87.26	8.1	0.0
12.0	0.0	0.00	88.00	0.0	0.0
11.0	1.23	0.00	87.77	0.0	0.2
10.0	2.51	0.00	87.49	0.0	0.4
9.0	3.87	0.00	87.13	0.0	0.6
8.0	5.28	0.00	86.72	0.0	0.8

Gas burned 86.0 percent CH_4; 14.0 percent C_2H_6.

Bolivar Refinery *Improved To Produce* Special Naphthas

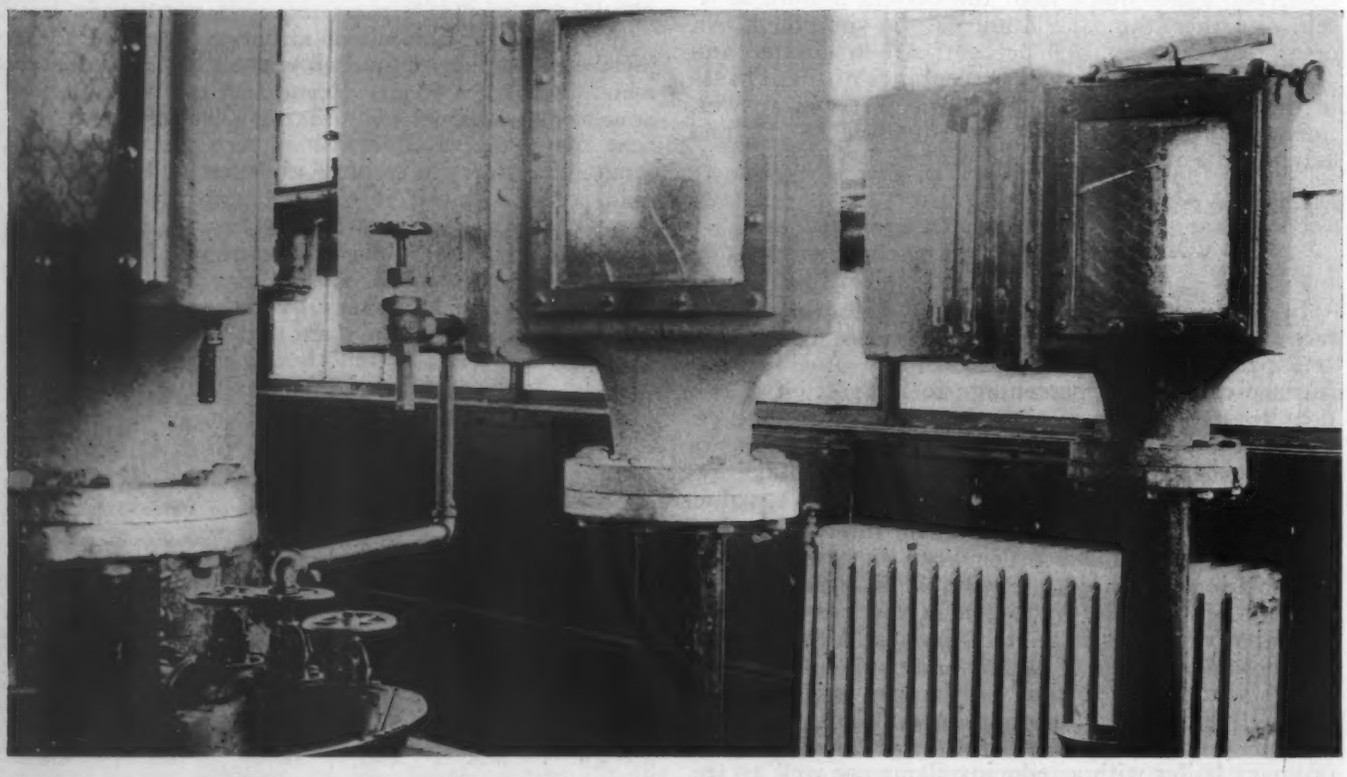
J. C. ALBRIGHT

THE Alleghany Refineries, Inc., plant at Bolivar, New York, is a combination skimming, special naphtha production and stream refined stock manufacturing process, and has a rated capacity of 1500 barrels of crude daily. The oil used for processing through this plant is produced by the owners of the refinery who pooled their interests so a market could be developed which would provide an outlet for the production from the many stripper wells in the Bradford, Pennsylvania, area. As most modern plants are designed, provisions were included in the layout of the different units so advantage could be taken of all available heat. The plant was designed by Dr. E. H. Leslie and erected by Leader Industries, Inc.

Salt water is produced in small amounts from most of the wells in southern New York and northern Pennsylvania, and like all oils in that region, gives up the saline content reluctantly. Heat is necessary to separate the water from the oil before the charge enters the tube still. All exchangers and product coolers are placed in the line of operation so the crude acts as a partial condensing agent, and at the same time, receives the benefit of the heat present at these points.

After passing through the overhead stream exchanger, (gasoline to crude), and the various side-cut exchangers, the oil enters the salt separator at a temperature of approximately 325°F. The pressure on the charge is held at about 200 pounds in order that vaporization of the lighter fractions will not take place. In the design of most units of like character, a preliminary flash chamber is provided to remove a part of the volatile fractions before the balance of the charge enters the pipe still. However, it was desired that the vapors together with the heavier fractions should be passed through the tubes of the pipe still where the complete charge could be flashed simultaneously into the main column.

The temperature held on the transfer line at the pipe still averages approximately 700°F. The main



Look boxes with specially cut wiers to show the rate of flow of the various products coming from the fractionating column.

column is 110 feet high. A cut of medium end-point gasoline is taken from the top of this column, averaging around 350°F. end-point, a part of which is used later in the preparation of motor fuel. When the plant was first placed in operation, all of the several cuts were sold in bulk to outside jobbers and other refiners. During the past year, the company has added a distribution system of its own, and markets practically all of the material suitable for automobile consumption through company-controlled outlets.

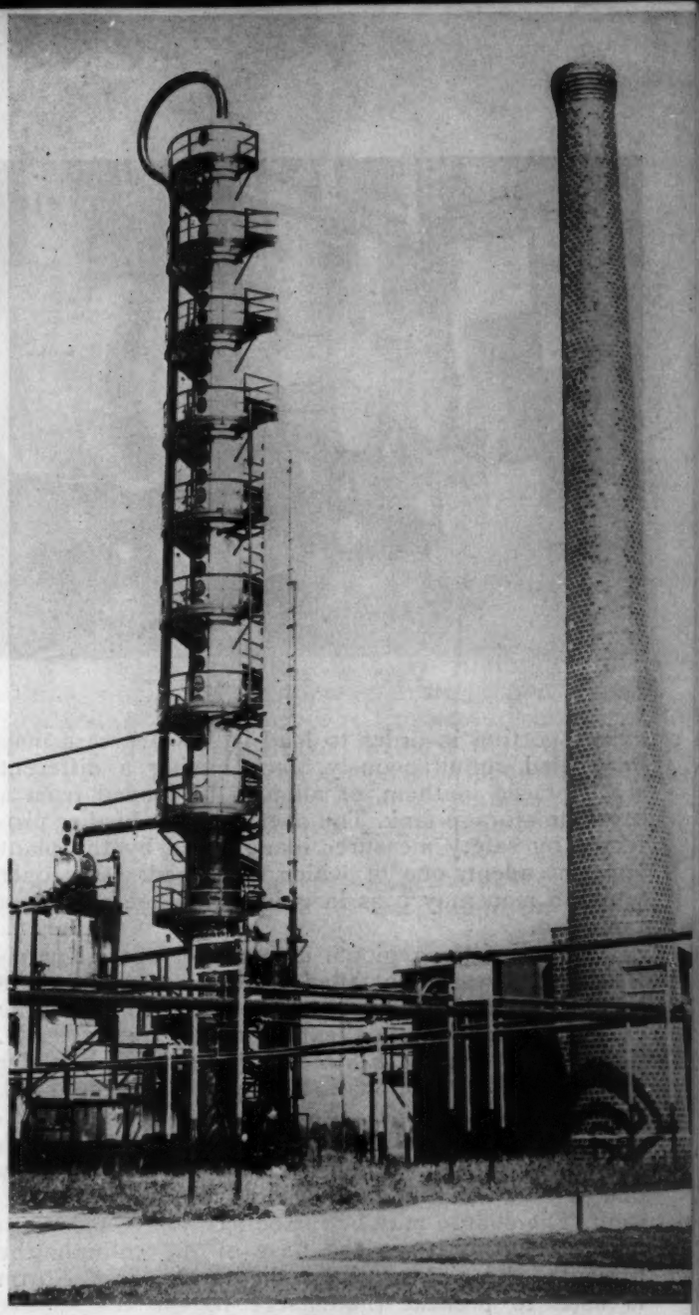
Sufficient natural gas is produced from the company's oil wells to supply fuel for the distillation unit and the boilers in the plant. Provisions, however, were included in the design of both units so that fuel oil could be used instead of gas if conditions were encountered which would make the change necessary. The operation of the furnace, so far as fuel is concerned, is automatic, with the proper heat obtained through the use of adequate control instruments.

Seven cuts are removed from the main column, the first, or lighter fraction, entering into the manufacture of the company's premium grade gasoline, having an average gravity of around 62.5 A.P.I., and an end-point of about 350. While in the vapor state, it passes through an especially constructed upper section, filled with chemical tile, placed there to retard corrosion from the small amounts of sulfur compounds contained in the crude. These compounds have corroded plants in the upper part of the fractionating column, as well as the condensers on the lighter streams removed from the crude. The reflux used to control the top temperature of the main column is condensate removed from the overhead vapor line, and is returned to the tower to be introduced in the section containing the vitreous chemical tile.

Coming on down the column, the next cut removed is the naphtha stream, having a gravity of about 54 A.P.I., and an initial and end-point of 180°F. and 412°F. respectively. This cut is water white, and needs no processing for color improvement before being worked up into the secondary grade of motor fuel. Forty-four gravity kerosene is next in order, with three grades of fuel oil coming next. The first fuel oil is called No. 1, the second No. 2, and so on. They range in gravity from 44° A.P.I. through 42° A.P.I. to 39° A.P.I. This product, graduated in several different qualities, compares to the gas oils and other related products taken from Mid-Continent crude. Bottoms are generally considered as fuel oil in other sections of the country, but in Pennsylvania lubricating oil manufacturing sections, the bottoms are not fuel oil, but a residuum from which motor oils are taken.

Steam-refined bottoms are made at the plant, from which, when processed in the approved Pennsylvania manner, the usual grades of lubricating stocks can be prepared. The company was making plans at the time the writer visited the plant to erect a complete plant for the manufacture of a full line of finished motor lubricants, to be packaged at the plant.

An unusual feature of the plant is the design of the look-boxes in the tail house. Instead of the regulation pipe connections which admit the streams through the box, a specially constructed baffle, placed in a vertical position, is slotted to provide for a measured flow. Reading in inches, a given measurement is an indication to the stillman that a certain

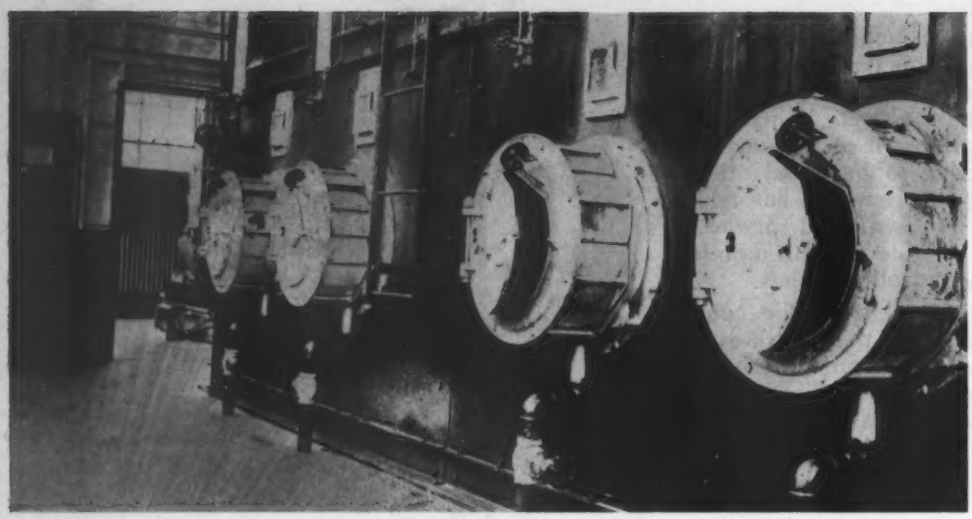


Allegany Refiners, Inc., plant at Bolivar, New York.

amount of product is passing through the look box, and by manipulating the various controls, a certain predetermined cut can be maintained when the plant is being charged with a given amount of crude. This arrangement obviates the necessity of gauging the run tanks to determine the amount of products made daily. However, gauging is done as a matter of routine, to provide a check on the hourly reading of the products passing through the look boxes.

Another interesting feature of the plant is the manner in which the steps, or stairway is mounted on the main fractionating column. The method provided for ascent is by a circular stairway, protected by handrails, so that the operator or inspection force can reach the top by walking upward, instead of climbing an unprotected ladder. The stairway is so built that it flattens out into a level walk opposite the manholes in the column so that repairs can be made without danger of injury.

The loading rack is somewhat different from usual in that the risers to which the fill pipes are connected are extended through the floor of the rack to occupy the least possible amount of space. They are arranged with fill pipes of a predetermined length so that it is not necessary to "pinch" a tank car to an



Power House Firing Front.

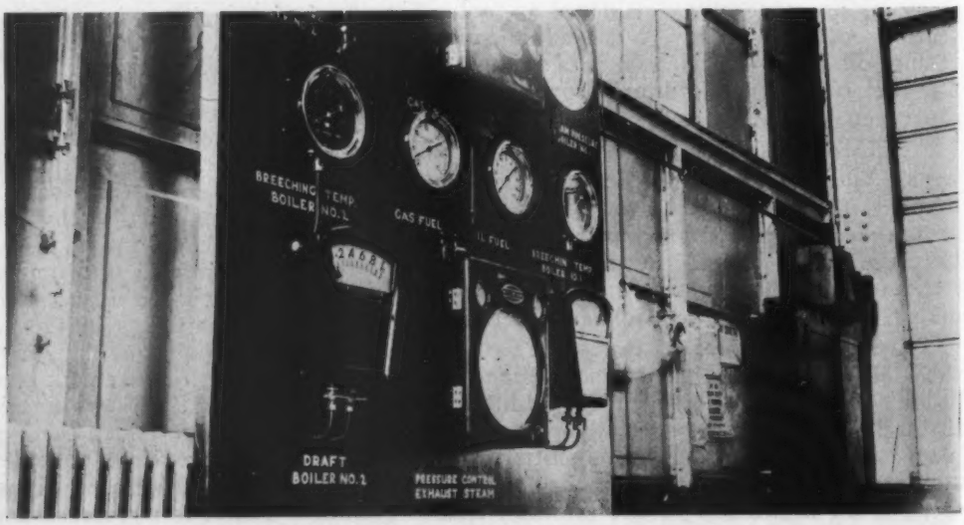
exact spotting in order to load it. Twelve cars may be loaded simultaneously, each having a different stock placed in them, or all may be loaded from a common storage tank. The operators are further protected by safety measures inaugurated by the plant superintendent, one of which is hinged walks over which a man may pass in going from the rack to a tank can.

Because of the regional demand for special naphthas, the company installed a special column beside the main fractionating tower in order to rerun the overhead stream when extra stocks are available. The special column is fitted with 30 plates in order that adequate fractionation may be accomplished, and the stocks, which are the surplus overhead gasolines from the main column, are pumped through a bottoms exchanger, serving as a preheater, to any one of four different introductory points in the column. The charge may be introduced above the ninth plate—counting from the base of the column, the fifteenth, the eighteenth or the twenty-first. Steam is used to preheat the charge to the temperaure necessary for maximum separation in the tower. A reboiler is used, consisting of a double unit, one of which is used with the kerosene stream coming from the main column, while the other is used with live steam. By using the kerosene stream for a partial heater, the amount of steam necessary is reduced considerably, which tends toward a more economical operation of the refinery as a whole.

By arranging the point of introduction to the special column, controlling the temperature of the charge, and the overhead temperature by refluxing, five different grades of special naphthas may be removed from the column through the overhead vapor line, which range in gravity from 62° A.P.I. to 74° A.P.I. The initial and end-points of the cuts range from 110-285 EP, to 200-285 EP. The bottoms from the special column constitute the Stoddards solvent, running in gravity from 47 to 49° A.P.I.

All plant buildings are of steel construction, equipped with sufficient windows that all parts within the rooms may be seen without lamps. The boiler room and air compressors are housed in a building separate from the distillation unit to provide an extra factor of safety. A well-equipped shop is maintained in which all routine repairs can be made, such as pipe threading, small lathe work and welding of parts, pipe fittings and other necessary work.

The general office is located on the refinery grounds. A well equipped inspection laboratory is maintained in a building, constructed of brick and steel, separate from the plant office. Research is being done within this laboratory looking forward to a continual expansion of manufacturing methods.



Control and Instrument Board in Boiler Room.

PRIMARY Distillation Unit

Has Interesting Operating Features

TWO YEARS ago, Sloan & Zook, pioneer manufacturers of natural gasoline, and one of the oldest firms engaged in producing Pennsylvania oil in the Bradford field, entered the refining business by purchasing the old plant of Seneca Oil Company at Warren. Previous to this purchase, the plant had been modernized except for a primary distillation unit. New boilers had been installed, a modern clay-burning unit was purchased and additional equipment was placed in operation for manufacture of lubricating oil.

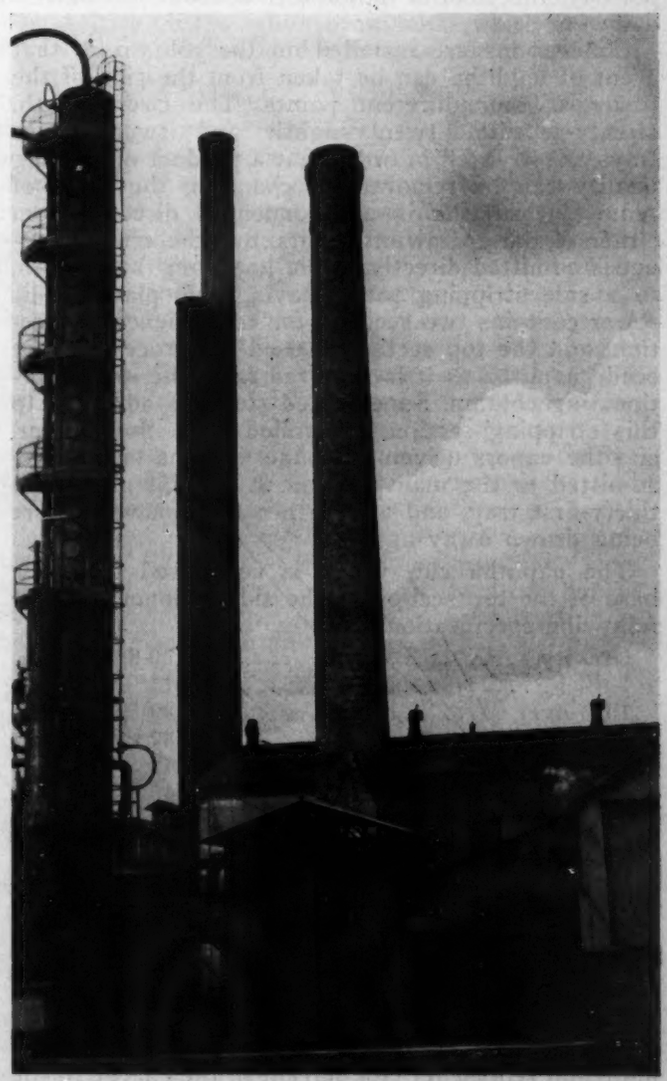
When the present owners took over the properties, the first step in a further modernization of the plant was the installation of an up-to-date primary distillation unit. Struthers-Wells, Titusville Corporation designed the entire plant and placed it in operation. The unit was originally designed to process about 1500 barrels of Bradford crude daily, but subsequent trial runs demonstrated that 2000 barrels could be run through the unit without throwing the column and other accessories out of balance.

The still is equipped with a double row of convection tubes above a sloping baffle in the front of the furnace with a single row of radiant tubes placed just below the convection tubes, and beneath the baffle. A bank of radiant tubes was installed in the front wall of the still setting, and a short bank of superheating coils was installed above the baffle through which steam is passed to be used later for processing purposes. Two burners are installed in the furnace which use fuel oil for heating the charge. Fuel oil in this case, and in most all cases in Pennsylvania, is a grade which corresponds to a Mid-Continent gas oil. Fuel oil, as known in other parts of the United States, is not manufactured, because the fractionating column, or flash tower bottoms, is the material from which Pennsylvania grade lubricating oil is manufactured.

The main column in this plant contains 41 trays, seven of which, in the lower section, are used for stripping the charge, while the remaining 34 are used as fractionating plates. A 10-inch vapor line leads from the top head of the column through which motor fuel is removed. The column is further provided with guarded platforms placed at convenient intervals to facilitate inspection.

The charge is passed to the unit through the operation of steam driven reciprocating pumps and the oil passes through a vapor heat exchanger, where advantage is taken of the heat contained in the cut taken from the top of the column. Three additional exchangers are placed in the line of flow, two of which are used as wax distillate exchangers, and the third used to pass the bottoms through as a partial cooler for this product, and to prepare the charge for its entry into the pipe still. The charged oil leaves the exchangers with a temperature of about 340/350° F. and enters the still through the overhead convection section, passing successively through the bottom row of radiant tubes and the section in the front wall of the furnace. The temperature imparted to the charge in its travel through the pipe still ranges from 700 to 720° F., depending upon the bottom products to be made. It enters the flashing section of the main column at a temperature around 710° F.

Superheated steam, prepared in the coil of tubes in the furnace, is admitted to the column through a



Sloan & Zook's primary distillation unit.

connection at the base so the bottoms can be stripped of any fractions not desired in the lubricating oil stocks. Flow meters were placed on the steam line to this section so the amount can always be known, and changes made intelligently. The cut removed from the top of the column represents the motor fuel fraction in the high-gravity Bradford crude charged to the unit. It is controlled by pumping a stream of the condensate back over the column as liquid reflux. The yield of this product averages around 37.5 percent, when a 43/45 gravity Bradford crude is charged to the distillation unit. The distillation of the product shows the following:

Gravity	63.5° A.P.I.
I. B. P.	94° F.
10% over	164
20	192
30	214
40	228
50	246
60	264
70	282
80	308
90	330
95	360
End point	372
Color	30

Calculated on an average charge of 1500 barrels per day, the yield of motor fuel is about 560 barrels daily.

Connections are installed on the column so that a cut of naphtha can be taken from the side of the tower at four different points. The twenty-sixth, twenty-seventh, twenty-eighth and twenty-ninth trays are so fitted in order that a product of varying quality can be removed by changing the point of removal. Naphtha is not condensed directly from either of these draw-off points, but the crude product is admitted directly, while hot from the column, to a side stripping tower having five plates. This tower contains two sections for convenience in erection, and the top section is used for processing the crude naphtha as it is removed from the main fractionating column. Superheated steam is admitted to this stripping section, controlled by a flow meter, and the vapors driven from the naphtha cut are readmitted to the main colnmn at a point above the thirty-first tray, and are further fractionated before being drawn away again.

The naphtha cut, which is condensed from the base of the top section of the side stripper, has the following specifications:

Gravity	50.6° A.P.I.
I. B. P.	311° F.
10% over	329
20	337
30	342
40	346
50	351
60	356
70	362
80	368
90	380
95	390
End point	408
Color	30

Kerosene is the next cut removed from the column, and represents 11.5 percent of the charge to the still. This product is removed from one of three draw-off points, placed at the twenty-first, twenty-second and twenty-third fractionating trays in the column. The cut is taken off through a 1½-inch line, and further processed in the lower section of the combined stripping column. Steam is also used in this stripper, furnished through the superheating coils in the furnace, and regulated by a flow meter. This product is controlled to specifications, and the undesirable fractions are returned to the plate next above the top draw-off point. The specifications are as follows:

Gravity	45.6° A.P.I.
Flash, open cup	145° F.
Fire	180° F.
I. B. P.	364° F.
10% over	418
20	428
30	434
40	438
50	442
60	448
70	456
80	464
90	480
95	495
End point	518
Color	25

Fuel oil (gas oil) and wax distillate, both light and heavy, are the next products to be removed from the column. Gas oil is taken from one of four plates, the fifteenth, sixteenth, seventeenth, or eighteenth, counting from the base upward—and is removed through a 1½-inch line. The light wax distillate is taken from the eighth, ninth, or tenth draw-off plate, and the heavy wax is removed from the fifth or sixth plate in the column. Gas oil is condensed, cooled and run to storage. The light wax distillate is led through the wax distillate to charge exchangers, while the heavier cut, being much smaller in volume, is cooled and subsequently blended with the lighter stock, if desired.

The percentages of yields vary as to the specifications of the bottom stock. Typical yields are as follows:

Products	600 Steam Refined	590 Flash	630 Flash
Gasoline and Naphtha..	37.5%	37.5%	37.5%
Kerosene	11.5%	11.0%	10.0%
Fuel Oil (Gas Oil)....	10.5%	9.5%	8.5%
Wax Distillate.....	20.0%	26.0%	31.5%
Stock	18.5%	15.0%	11.5%

These percentages have a direct relationship to the bottoms, and are controlled by the temperature of the charge in the transfer line, and the amount of superheated steam introduced into the base of the fractionating column.

The specifications of the various products—other than gasoline, naphtha and kerosene—are as follows:

	Fuel Oil (Gas Oil)	Wax Dist.	600 S.R. Stock	590 Flash	630 Flash
Gravity, °A.P.I.	40.9	34.0	...	...	24.3
Flash, open cup, °F.	220	300	550	595	630
Flash, Pensky-Martin, °F.	...	...	535	570	600
Fire, °F.	260	385	625	670	705
Pour, °F.	15	75	40	35	35
Viscosity	...	82	155	200	290
Carbon residue, %	...	...	2.21	2.97	3.42

Distillation Unit *Designed for* Double Duty

THE plant operated by Wolverine-Empire Refining Company, at Reno, a few miles from Oil City, Pennsylvania, represents the trend which refiners in this district have been taking in modernizing equipment. Two separate units are closely coordinated, each having separate functions, so that Pennsylvania-grade crude can be processed almost in a straight line from charging pumps to finished products.

Crude is picked up by a reciprocating steam-driven duplex pump and passed first through the tower overhead stream heat exchanger at 150 pounds pressure. After absorbing what heat is available from a tower top temperature of 236°F, the crude is released from the transmission lines into a salt settler where the salts are separated from it. It continues under process pressure from this part of the system to the wax distillate cooler, where a temperature of 637°F is maintained on the stream coming from the column.

After the crude charge has passed through the first three steps in the distillation unit, it is transferred to pipe still under a temperature of 320°F. When it has traveled through the tubes in this furnace, the temperature has been increased to a point where the transfer is at 740°F. Flashed into the column, which is six feet in diameter by 94 feet, four inches in height, separation of the various fractions takes place under a pressure of about five pounds, gauge. The total drop in pressure, from the discharge of the reciprocating pump, to the transfer line leading from the pipe-still furnace is about 136 pounds, or from a charging pressure of 150 pounds, to a transfer pressure of 14 pounds.

Superheated steam at the rate of about 1150 pounds per hour is admitted to the column to accelerate stripping of the various desired constituents from the heated crude. The lightest stream removed from the column is taken in the conventional manner from an overhead vapor line, 10 inches in diameter, and this stream is maintained at a temperature of 236°F. by passing a portion of the condensate back through a two-inch line to the tower below the top plate. In a normal run, this cut has a gravity of about 65.2° A.P.I., and may be used for motor fuel, or split up subsequently into special naphthas.

The first side stream is taken from the column at a selected point—two being provided in the design of the tower—and this stream usually has a gravity of about 46.2 A.P.I., and has a take-off temperature of 405°F. This cut is taken from the side of the tower through a 1½-inch line.
degrees, and is taken from the side of the column, a

The third side stream removed from the side of the column, also through 1½-inch line, under a control temperature of about 522°F, has a gravity of 40 A.P.I. The fourth side stream has an A.P.I. gravity of 34.8 degrees, and is taken from the side of the column under a temperature of 637°F. Bottoms in the column have a flash of 560°F, and are cooled and sent to storage for further processing.

By varying the operating conditions of the unit, the temperature of the transfer line, the temperature of the column and the amount of superheated steam introduced into the column, a variety of materials may be removed from the fractionating column, but the normal runs are as outlined above.

Naphtha, or the first side cut, may be run through a side stripper, three feet in diameter, to control the initial boiling point of the product. When the side stripper is used, superheated steam is introduced into the base to drive off the lighter constituents which re-enter the column through a four-inch vapor return line to be refractionated.

As the principal product desired in the distillation of Pennsylvania Grade crude oil is the lubricating fractions, the bottoms from the fractionating column are processed further in another part of the plant to remove the waxes. The fractions used for lubricating purposes are chilled in the usual manner employed by Pennsylvania refiners, after being mixed with a naphtha diluent, and processed through centrifugal machines to remove the wax.

After the waxes are removed, the lubricating cuts are returned to the unit for further processing. The unit is a double plant designed and erected by Alco Products, Inc., the first, which has just been described being used for primary distillation, and the second, where the dewaxed products are reprocessed. The charge is passed through the second furnace where the oil is heated. The charge is brought up to a temperature sufficiently high that the naphthas are driven from the product and are taken from an overhead line in the same manner as the gasoline, or light fraction in the primary distillation unit is taken.

The desire of the Pennsylvania refiner today is to produce an increasingly greater amount of neutrals, so the demand for lighter S.A.E. grades of motor oils may be met. The demand for grades of 10, 20 and 30 S.A.E. oils has disturbed the balance between neutrals and bright stocks, consequently a greater need is felt for the neutrals.

Two side cuts are taken from the rerun unit, one being a light neutral, and the second being the heavier product. The streams are both passed through side strippers to control the quality, while the bottoms are taken out as bright stocks.

The subsequent operations of the lubricating plant are carried on in the usual manner, with the blending processes handled so that the various grades of lubricating oils may be produced, canned, barreled or sold in tank car bulk cargoes.

COMBINATION

Preheater, Trap and Boiler Feed

Water Heater

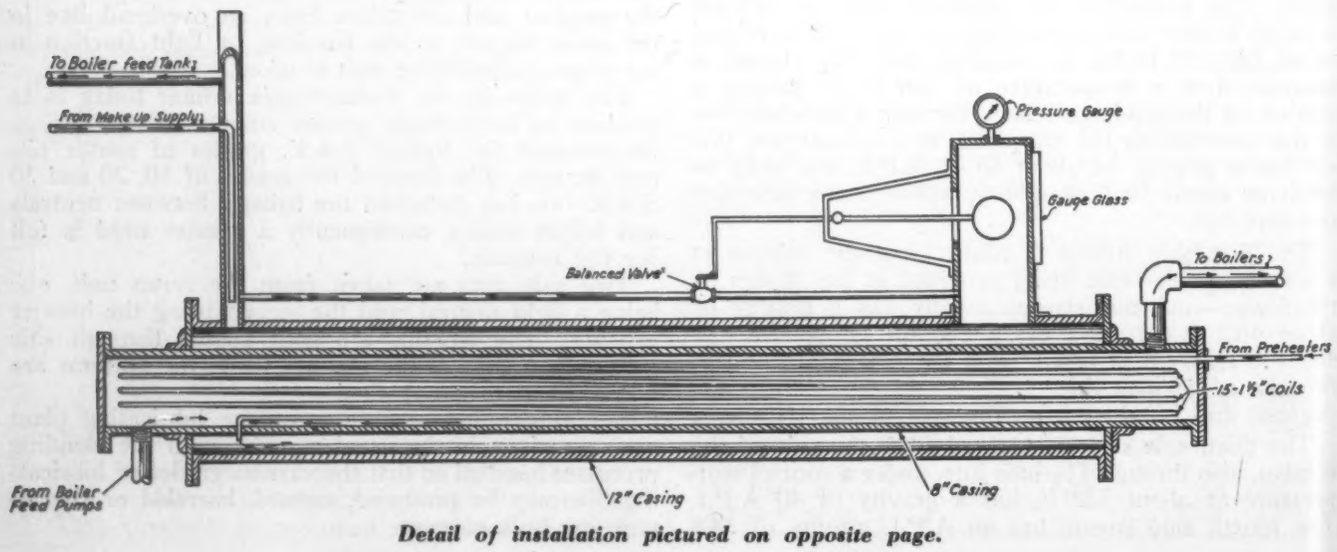
WHEN Gilmore Gasoline Company, experienced difficulty in trapping steam condensate from the discharge of the preheaters to the boiler feed-water supply tank with a considerable loss of heat and evaporation, plant engineers at plant No. 1, Long Beach, California, designed a simple automatic combination preheater trap and boiler feed water heater. It not only performs the duties expected of it, but performs them without supervision and with only a minimum amount of maintenance.

Before this apparatus was placed in operation, the water was introduced to the boilers direct by draining down through a trap, but this method was unsatisfactory, because water would not trap out of the preheaters as fast as condensed, and backed up in to the shells and interfered with the efficiency of the distillation system. Pumping directly through a float controlled system by using a special pump also was found unsatisfactory.

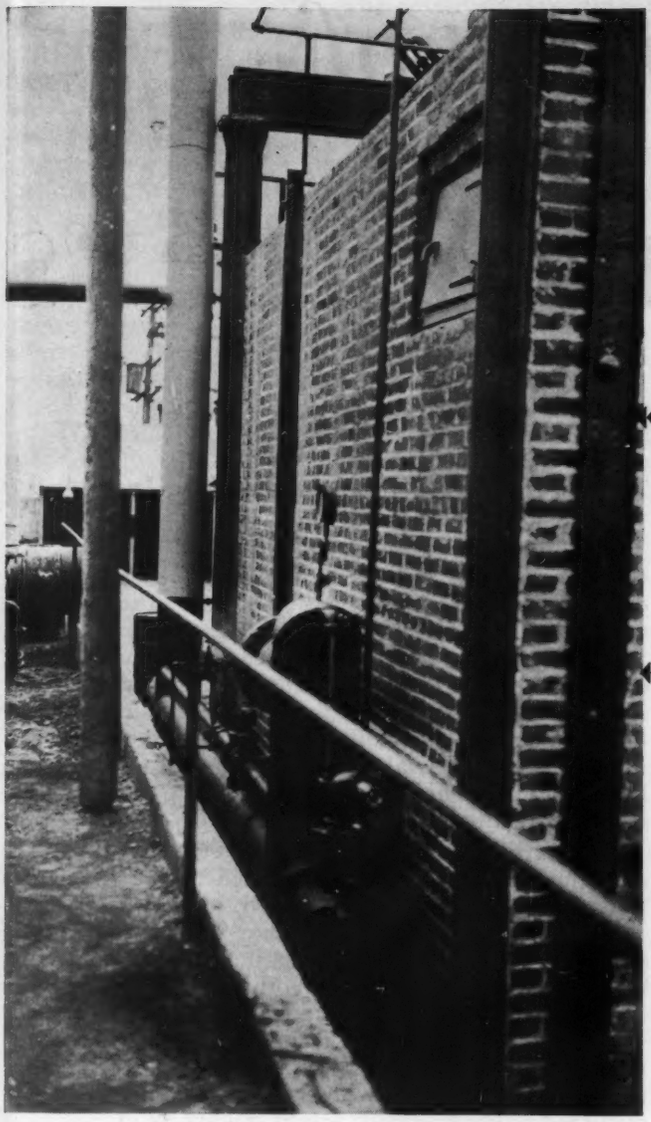
This unit, combining preheater trapping and boiler feed heating in one piece of equipment is simple, both in operation and manufacture. Two joints of pipe were secured, one of which was twelve-inch, and the other eight-inch. The eight-inch section is the longer because of the desire to extend it through the twelve-inch section with compartments, or ends, so fittings could be attached. Heads were prepared for the eight-inch section, one of which was placed blind on one end. Fifteen joints of 1½-inch pipe were placed inside the eight-inch as a bundle, connected to each other in series with short center returns. When placed, one end was left with an extension so it could extend through a hole in the head of the eight-inch. The other free end was welded to the lower side of the eight-inch so water could pass through the bundle and out of the shell.

The eight-inch with its bundle was inserted into the twelve-inch pipe and welded to it with rings to form a uniform annular space between the two joints. Two-inch nipples were welded to the eight-inch, one at either end. One of these was connected to the line leading from the boiler feed pumps, and the other connected to the supply line running to the control valves on the water level units.

A float chamber was made and fitted to one end of the twelve-inch pipe to form both a float chamber and a small reservoir for water. The float arm bearing was taken from a unit not in service at the plant



Detail of installation pictured on opposite page.



Home made combination preheater trap and feedwater heater. Gilmore Gasoline Company, Long Beach, California.

and flanged to one side of the float chamber. To permit water to flow from the twelve-inch casing and the float chamber, a 1½-inch line was connected at one end to the lower end of the float chamber, and the other to a riser welded to the opposite end of the unit. The riser is an atmospheric discharge line having two other lines connected to it at right angles; one of which is the true discharge line from the riser, and the other extends through the walls of the pipe and continues downward to a point near the outlet of the 1½-inch line leading from the float chamber. Boiler feed make-up water is introduced through the second line which returns to the supply tank with the condensate from the preheaters.

The float arm is connected to a balanced valve connected in the 1½-inch line leading from the float chamber to the riser which governs the volume of water flowing through the unit. The float chamber is fitted with a gauge glass to indicate the level of the condensate coming from the preheaters, and a gauge was placed on the upper head to indicate the internal pressure.

In operation, the water continually drains downward through a one-inch line from the outlet of the preheaters. Steam is introduced in the conventional manner to the bank of preheaters, with the boiler battery being operated at 140 pounds gauge. Due to the restricted size of the transfer line, the pressure on the float chamber and unit is only 50 pounds. This small line was intentionally placed in the system to place a restriction on the flow to prevent draining of the steam condensate too rapidly.

As the water flows through the bundle of 1½-inch pipe inside the eight-inch pipe, it interchanges heat with the water being pumped to the boilers. The steam condensate released from the pipe bundle inside the eight-inch, flows around the eight-inch in the annular space, and exchanges heat to a further extent with the water flowing to the boilers. The float maintaining a constant level in the chamber maintains a level of sufficient height in the unit that steam cannot flow from the oil preheaters to the unit.

The cold water entering the vent pipe reduces the temperature sufficiently on the steam condensate leaving the unit that no appreciable evaporation is evident. This would be shown by the cloud of water vapor continually leaving the make up tank. The unit has been in operation at this plant two years and has performed in a satisfactory manner. The cost of the installation was negligible, the casing and many other parts necessary for its construction was salvaged from surplus materials, only the bundle of 1½-inch pipe being purchased new. The unit is not insulated, because only the water that it is desired to cool comes into contact with pipe with a surface exposed to the atmosphere.

Internal Treatment of

Boiler Waters

J. S. WALTON
Member of Staff
De Florez Engineering Co., Inc.

THERE is an adage of old time water treaters which says: "Never add anthing to boiler water if the boiler can be operated without the addition." And today this axiom is trustworthy in most cases in spite of guarantees of myriads of eloquent salesmen for chemical concerns. There are however, cases where elaborate methods of treatment are necessary, and often internal treatment is the best, as well as the cheapest solution to a boiler water problem.

Internal treatment of boiler waters can be divided into four main types, treatment to prevent embrittlement, scale prevention, diminution of foaming and priming tendencies, and corrosion prevention.

There is much to be said for and against the necessity of safe-guarding boilers from embrittlement. In the first place embrittlement is most apt to occur in boilers operating at high pressures. In the majority of refinery power plants, boiler pressures do not exceed 150 pounds. The reaction;

(1) $Na_2CO_3 + 2H_2O = 2\ Na\ O\ H + H_2O + CO_2$

is accelerated at high temperatures existing in high pressure installations.

Not many men have seen actual cases of embrittlement which have occurred in operating boilers. Indeed, a vote from inspectors would indicate that the danger from this source is small. On the other hand, in a few cases boiler failures have been caused by embrittlement, and only one failure is enough to be considered serious, not only from the point of danger to human life, but also from the cost attendant to replacing equipment, and the losses incurred from idle plants during the shut down period. Granting the existence of embrittlement in actual boilers, can it be prevented? How can it be known if embrittling condition exist? Supposing embrittlement has actually occurred, then how can it be detected in some of the older and smaller boilers where access to the rivets and seams is impossible without dismantling the whole boiler?

One of the pioneers in embrittlement prevention and study, has perfected a treatment which he believes to be the best one in existence, and yet he frankly states that while he can say in all sincerity that he believes his treatment will prevent embrittlement, he cannot absolutely guarantee safety. This should be all the answer necessary as to whether it is possible to prevent embrittlement. The belief that protection can be given arises from the same source as the second law of thermodynamics—experience. When an event occurs or fails to occur in a number of cases under a given set of conditions there is a probability, mathematically definable, that the event will occur, or fail to occur again under the same conditions. If the same set of conditions has caused the same result in a great number of cases without exception, the probability is great that the same set of conditions will invariably cause the same result. If the number of cases is infinite the probability becomes a certainty. Prevention of embrittlement by accepted treating methods is therefore not a certainty, but the probability of successful prevention has had enough trials so that the danger from embrittlement when using proper treating methods becomes vanishingly small.

Embrittling conditions are not even known for a certainty, but have become defined in the same way that protection has been secured, by experience and research. Thus it is known that under certain conditions of alkalinity of the boiler water, embrittlement has occurred. Under other conditions it has never occurred. In between these two opposites there are regions where it has sometimes occurred and sometimes not. The safe limit has therefore been set in the region where embrittlement has never occurred either in many actual boilers or in innumerable laboratory tests.

The question must remain unanswered at least for the present, as to how embrittlement can be detected if it is suspected to have occurred in an inaccessible boiler drum. If embrittling conditions, as defined above, exist or have existed in an inaccessible location, there are three solutions: go on operating as before and trust to the fact that the boiler inspector in the territory has never seen a case of embrittlement; begin proper treatment at once and hope that the harm has not already been done; or shut down the boiler.

As a last argument against the use of preventive treatment it can be asked why much time, expense, and added troubles from higher boiler concentrations should be entailed in order to safeguard against such an ephemeral foe as embrittlement. It can be stated, and with some grounds too, that the actual cases of embrittlement in practice have been so few that probability considerations are not applicable, and that it has merely been a coincidence that no embrittlement has been found in boilers where treatment has been used. Again, to these objections there is no absolute answer. It is true that preventive treatments are expensive, and it is also true that the treatment sometimes does (not usually) aggravate foaming and priming troubles. The objection can only be answered by the thought that it is better

to be safe than be sorry. The relatively few actual cases of embrittlement occuring in commercial boilers does offer data slightly disputable from a probability standpoint, but the hundreds of laboratory experiments performed, all support the plant data and leave little room to doubt the efficacy of the embrittlement prevention treatment.

There are two chemical radicals which have been found to be the most effective in preventing the occurrence of embrittlement. These are the phosphate and the sulfate groups. Phosphates normally are added to the boiler water as the monosodium phosphate. The action of the phosphate is a positive reaction, in that the main cause of embrittlement, sodium hydroxide, is decomposed or neutralized. Because of this positive action, and also because of its scale prevention action, phosphate treatment is particularly attractive. In spite of the claims of the distributors, the main action of phosphate in preventing embrittlement probably is of the simplest neutralization type represented by some equation similar to

(2) $Na\ H_2\ PO_4 + 2\ Na\ OH = Na_2\ PO_4 + 2\ H_2O$

There is also a possibility that some additional inhibitory effect is obtained by changing the hydrolysis rate of carbonate to hydroxide but until equilibrium values and solubilities at boiler temperatures are better known, the magnitude of this action is conjecture. If the neutralization reaction as shown in the foregoing equation were the only beneficial result obtained from the use of phosphate it could be truly said that any mineral acid would be equally effective in neutralizing the hydroxide. Phosphates, however, also combine with calcium and magnesium salts, which if left alone would cause scale, and if silica is present, a very hard scale. Calcium phosphate will itself form a troublesome scale in feedwater lines, but once in the boiler the precipitate does not adhere firmly to tubes (or drum) and can be removed in the blowdown. To eliminate clogged feedwater lines the introduction of phosphate in slugs is usually practiced.

Due to the nature of the reactions occurring between boiler water and phosphates, no higher concentration of dissolved solids is caused by the addition of the foreign salt, unless a large excess is added, which is unnecessary. Under certain conditions however, the addition of phosphates can cause vigorous priming. For example, one case occurred where the phosphate method had just been installed and concentrations in the boiler water were considerably higher than necessary. A hot process lime-soda treat was used on the feedwater and just before the prolonged priming occurred faulty operation of the chemical proportioner had caused an excess of lime to be thrown into the feedwater. When this hard water reached the boiler and the lime was suddenly precipitated as calcium phosphate, a very strenuous time was had by all concerned trying to keep water in the drums. In cases of this kind the calcium phosphate is thought to exist as a very fine precipitate which does not settle readily.

Sodium sulfate is also widely used in prevention of embrittlement. Its action, unlike that of phosphate, does not consist of removal of the unwanted constituent, but is rather a protective action. The mechanism of protection is conceded to be the deposition of a coating of sulfate in the seams of a drum or in cracks where localized precipitation of the dissolved salts in boiler water occurs when the water is evaporated. It has long been known that caustic attacks the crystal structure of iron, causing a weakness which eventually may rupture under strain. Caustic also will attack iron at high temperatures with the liberation of hydrogen according to the reaction

(3) $FE + 2\ Na\ O\ H = H_2 + FE\ (O\ Na)_2$

Research also has shown that sodium carbonate, although forming the deleterious caustic by hydrolysis according to equation (1), does in itself offer protection from embrittlement, so that in all considerations of safe limits of the ratio of caustic concentration to sulfate, the concentration of carbonate can be taken into consideration also, thus lessening the necessary sulfate concentration. As stated previously however, the mechanism of protection is certainly a solubility proposition and future research undoubtedly will furnish positive data as to the desirable relative concentration of the three radicals now known to be concerned as well as others such as phosphates, chlorides, etc. Safe limits of concentration have been set from a few actual boiler experiments and many laboratory tests. Copies of charts showing the concentrations now believed to be safe can be obtained from most of the companies selling water treatment chemicals, as well as from the A. S. M. E. proceedings or from Straub's bulletins.

Sodium sulfate is added directly to the feedwater either before or after treatment, and has the advantage over phosphate in that not as careful control of the quantity added is necessary, since about the only important things to be considered in the addition of this chemical are the cost of the chemical and the concentration of dissolved solids in the boiler water. The sulfate probably does have a tendency to form a sulfate scale by combination with residual hardness in the boiler water, but this tendency is at most slight, and sulfate scales are about the least troublesome in refinery power plants which are equipped with any form of water treatment apparatus.

Sulfate concentration can also be added to boiler waters by the direct addition of sulfuric acid to the feedwater either before or after treatment. If used before treatment a double cost of chemical is necessitated since it is then necessary to neutralize any acid added and then after neutralization use enough excess chemical to drive the softening reaction to the desired degree of completion. If the acid is added after treatment this extra chemical is avoided but then the question of corrosion of lines and boilers becomes important. Probably the best opportunities for the use of acid occurs when the raw water requires a large excess of soda ash to secure the necessary degree of softening or when no treatment of the feedwater is used. Soda ash, if allowed to enter the boiler, would form caustic by hydrolysis, so its removal by acid is incidentally advantageous along with the addition of sulfate. In a case such as this a tank for the treated water should be provided so that the generated carbon dioxide can be vented as completely as possible. In a cold process treatment the amount of carbon dioxide remaining in the water is large and attendant corrosion troubles probably would make acid addition after treatment unwise.

INTERNAL TREATMENT FOR SCALE PREVENTION

Except in the case of field boilers internal treatment of boiler water customarily is used only as a

supplement to the pretreatment of the feedwater. Silica and sulfate scales are the two main types which cause trouble, and of these two the silica scale is by far the most troublesome, both from the viewpoint of prevention and from adhesiveness and difficulty of cleaning.

In usual feedwaters the silica content is low, usually not exceeding 0.5 grains per gallon but unfortunately silica possesses two properties which tend to cause its concentration in the boiler. In the first place silica at ordinary temperatures is an inert material and does not react with the usual chemicals used in treatment of feedwaters. In the second place the solubility of silica increases with increasing alkalinity. For these reasons an initial silica hardness of 0.5 grains in the feedwater can, in a boiler with 10 per cent blowdown, build to 5.0 grains hardness in the more highly alkaline boiler water.

Once in the boiler at a comparatively high concentration, the silica reacts with residual calcium and magnesium hardness in the incoming feedwater, to form calcium and magnesium silicates, both of which compounds form a very hard adhesive scale.

For the prevention of silica scale by internal treatment, three compounds deserve mention — phosphates, sodium aluminate, and various organic liquids sold under trade names usually designed to show at least partially the use for which the chemical is intended.

The action of phosphate in preventing scale formation already has been mentioned in the discussion of embrittlement, the reaction with a compound showing soap hardness being represented by equations similar to

$$3\ Ca\ C\ O_3 + Na\ H_2\ P\ O_4 = Ca_3\ (P\ O_4)_2 + 2\ H_2\ CO_3 + Na_2\ CO_3$$

the calcium phosphate being eliminated in the blowdown. It should be noted that in the above reaction carbon dioxide would be liberated in the boiler which is undesirable, and also that the reaction as shown tends to increase the alkalinity of the boiler water by increasing the concentration of sodium carbonate. With another type reaction such as with a hydrate of calcium or magnesium the phosphate would cause the production of sodium hydroxide, this compound being distinctly objectionable from the point of view of embrittlement.

Sodium aluminate as sold on the market can be purchased either in the liquid or solid state. It is used widely both for pretreatment of feedwater and for the internal treatment of boiler water. It is an excellent coagulant, producing a large active floc. By its use with certain types of feedwater it is possible to materially lower the minimum hardness obtainable with a straight lime-soda treat. When used in the boiler as internal treatment it is effective in reducing calcium and magnesium hardness. It has been claimed that aluminate is particularly effective in the treatment of magnesium hardness and experience has come to bear out this claim at least in some cases. Once injected into the boiler water, the hardness is reduced and removed in the blowdown immediately since along with the treating action, the flocculation quickens removal of precipitates formed. Aluminate is probably at its best when the feedwater to the boilers has not been well settled out or filtered and contains, along with any residual dissolved hardness, scale-forming compounds in milky suspension.

It should be remembered in considering the use of aluminate, that part of its treating action (when purchased as a liquid) arises from the fact that it usually is dissolved in caustic, which is itself an active treating agent. Also that if the sulfate-hydroxide ratio is low in the boiler water, the use of aluminate internally (when dissolved in hydroxide) is not good practice, since the addition of caustic to the boiler will of course increase the hydroxide concentration and therefore increase embrittling tendencies. In the past it has been difficult to obtain solid aluminate which could be kept in solution. This feature has retarded use of solid aluminate because too often after adding the aluminate to the chemical tank for a period of a few days, it would be necessary to clean out the tank. It would then be found that instead of the aluminate dissolving in the chemical mix, it had rather settled to the bottom of the tank and solidified there. Reputable companies now are selling solid aluminate which they claim is free from this objection.

Railroads were among the first wide users of organic chemicals as boiler water conditioners. No one has successfully synthesized the compounds now being sold by chemical companies but it is known that the majority of them are mixtures containing tannin and complex glucosides. Sea weed is the reputed source of some of these mysterious—and expensive—liquids.

These compounds are always used internally since they have no softening action, nor does anyone know how the beneficial reactions occur. At any rate they serve two purposes, reduction of scale and prevention of foaming. As scale preventives these organic liquids perform very satisfactorily even on the difficult constituent silica, and in place of the customary hard brittle scale found before use, only a thin pink scale which can almost be removed with the fingers is found if the chemical has been properly added. Extreme cases are known when the addition of a certain organic liquid has resulted in the removal of scale from a boiler during a run so that in place of shutting down to clean up. the boiler not only was run longer but more efficiently at the end of the run than at the beginning, and was brought down practically clean. No positive reasons are known for the action of these compounds but from their physical properties, the theory is extant that scale-forming molecules adsorb or become adsorbed to organic molecules and are thus rendered incapable of joining together into any body more compact than a soft spongy mass. These liquids as commonly obtained have a very slight alkaline tendency but do not contribute appreciably to the alkalinity of the boiler water, since only a very small amount of addition is necessary.

TREATMENT TO PREVENT PRIMING AND FOAMING

So much unbiased information has been published on the causes and conditions governing priming and foaming that an explanation of these phenomena is needless. A distinction should be made here however, between foaming and priming so that subsequent discussion of internal treatment will not be confused by terminology. Although some authorities make no distinction between these two phenomena the practice has been followed in this paper

of designating priming as a violent ebullition usually occurring spasmodically although the variations can be rapid enough to appear continuous. Foaming is taken to mean a lessening of free vapor space in a drum because of the surface of the liquid becoming filled with foam or bubbles. These bubbles can rise enough to entirely fill the drum and thus be carried into the main steam line to the plant or into the superheater where evaporation of the water in the foam leaves the solid material as a scale.

Boilers operating at excessively high ratings are much more prone to priming tendencies than are those run at lower duties, and blowdown ceases to be practical when certain limits in percentages are passed. It is in these cases that internal treatment is valuable in decreasing the percentage of blowdown necessary to prevent priming. Suspended solids are more active in causing priming than are dissolved solids although both exert their influence. It is possible, however, to operate a boiler at very high ratings with a high dissolved solid content if the suspended solids are kept low, in the neighborhood of 5-10 grains per gallon. Low suspended solids can be obtained by a very careful control of pretreatment but probably the easier way is to use a coagulant in internal treatment. Sodium aluminate is the one most widely used and usually proves satisfactory. As stated previously the aluminate will also remove hardness in the boiler water and prevent scale formation. When using a coagulant internally, size and properties of the floc is very important since the floc should settle rapidly so that it is quickly removed in the blowdown and does not stay suspended in the boiler, thus defeating its own purpose. In addition it should be very active in gathering impurities. Sodium aluminate possesses both of these properties. The floc formed by its action is one of the most efficient clarifiers known, and in addition settles out sharply. Other coagulants are sometimes used, particularly on field jobs and can be made to perform their task satisfactorily. For operating within close limits of suspended solids however, it is doubtful if aluminate can be excelled.

Contrary to general belief, foaming is more troublesome in refinery power plants than priming. The action of priming is so vigorous, and noticeable however, that it is customarily thought of as being much more troublesome than foaming, as it undoubtedly would be if it occurred as often, and as prevalently as does foaming. The latter is a comparatively gentle phenomena and can exist unnoticed unless it occurs to such an extent that carryover becomes noticeable from excessively low quality of the steam. In refinery vicinities the water in rivers, lakes, and even shallow wells is usually high in organic matter and oxygen demand value. Dissolved organic material is the cause of most of the foaming occurring in water heaters, or for that matter in any other heating process where water is used. Doctor recovery is a good example. A satisfactory lay explanation is possible for this phenomena. Soap, as almost everyone knows, can be made by the action of sodium hydroxide on almost any of the weak organic acids of the higher molecular weights. It is even unnecessary that the molecular weight be very high, since a very satisfactory soap can be made from glycerine. The process of saponification, as this action of hydroxide or soda is called, is hastened by high temperatures with agitation. Steam is an agent often used to help out saponification reactions. It is then evident that given the necessary organic material inside the boiler, conditions are ideal for soap making, because of the presence of hydroxide and soda ash. Soap then is manufactured inside the boiler and while being agitated it forms a foam.

As is the case with priming, one of the most satisfactory ways to eliminate foaming is by the use of coagulants. With the lime-soda treatment the floc obtained in the treater will often decrease the organic material enough so that foaming will not occur, but in other processes, and with exceptionally bad feedwater when using the lime-soda pretreatment, an inside coagulant is efficient. Aside from organic material, the dissolved solids also exert their influence on foaming because of surface tension action. For this reason blowdown is also effective in decreasing foaming although not so effective as in the case of priming. Also as opposed to priming, foaming can and does occur in boilers operated at low ratings. Because the increase of dissolved solids exerts an influence on foaming, the introduction of a coagulant such as aluminate, when dissolved in caustic increases the amount of dissolved solids and can therefore act in the opposite direction than is desired. Tannin extracts and other organic mixtures have been used in some cases for both foaming and priming troubles but this practice has decreased rapidly during the past few years.

Various charts have been circulated which are purported to show the allowable limits for suspended solids, dissolved solids, and organic material before priming and foaming will occur. These charts are not reliable except to give the order of magnitude of the correct conditions and it will be found that there are particular considerations governing each particular problem. Solution of the problem best can be obtained by first hand study, rather than by generalizations.

CORROSION

Interest in this aspect of internal treatment for boiler water is localized in areas where a water of very unusual composition is found, or in industrial areas, where the only water available has been contaminated by other industries and industrial wastes. Corrosion also is a problem in field boilers where the temporary nature of the installation makes pretreatment of the feedwater uneconomic because of the cost of building the treating plant.

The pH of the boiler water is usually the important factor to be watched in a problem of this type. Usually an extremely high or extremely low pH is caused by free alkalinity or acidity in the water, although in rare cases the decomposition of compounds such as magnesium chloride will be found to be the factor contributing the corrosive constituent. Liberation of carbon dioxide when present in temporary hardness or when evolved by the action of acid on carbonates also is troublesome.

In the case of free alkalinity or acidity, the simplest solution is the regulation of pH by the addition of acid or alkali as required to maintain the correct value. Caustic corrosion occurs only at high temperatures and for this reason is found only in high pressure installations, although embrittlement which is not strictly corrosion, occurs at any pressure. The

corrosive action of caustic on iron occurs during the reaction.

$$FE + 2\ Na\ O\ H = H_2 + FE\ (O\ Na)_2$$

and is of course accompanied by evolution of hydrogen.

Acid corrosion is caused by the action of an acid on a metal and can be illustrated by the equation:

$$H_2\ SO_4 + FE = FE\ SO_4 + H_2$$

The reaction may form anyone of several known forms of iron sulfate but the results are the same in any case.

Generalizations as to the safe pH values are not possible due to the wide variations in operating pressures. For the ordinary field boilers operating at say 90 pounds pressure, acidic corrosion may occur at pH values as high as 9.0 and for higher pressures goes to about 9.5 or 9.6. For ordinary type boilers at lower pressures, caustic corrosion will not occur but at higher pressures the safe limit approaches the safe acid values. Generally speaking for 200 pounds pressure a pH of 10.5 is on the safe side but for high pressure installations about the only safe range from both acid and caustic corrosion is 9.5 to 9.7.

The discussion in the foregoing pages has not been written as a guide to treatment of all boiler waters since individual problems may require methods of treatment not even touched upon here. In general however, one of the methods described will be found to be the correct treatment in a majority of industrial problems encountered.

Normal Pentane

By I. N. BEALL
Chemical Engineer

THERE are three pentanes, namely normal, iso-pentane and neo-pentane. All three have the same formula, $C_5\ H_{12}$, the differences in physical and chemical properties being due to the different ways in which the hydrogen and carbon atoms are combined. All three are constituents of natural gasoline. In a previous issue, the physical and thermodynamic properties of iso-pentane were given. The tables presented herewith are for normal pentane. The tables should present some interesting comparisons both from a scientific and practical viewpoint. For purposes of making heat balances such as are used in the design and operation of rectifying systems, these tables should be of valuable assistance. All values used are felt to be well within the accuracy required for engineering calculations.

The pentanes are used as raw material for the manufacture of the amyl alcohols and amyl acetates. For chemical processing the purity of the raw material is important. As fractionation provides the only practicable means for the isolation of the pure compounds, actual physical and thermodynamic data in tabular form should be of assistance to engineers engaged in the design of equipment for that purpose.

TABLE 1

Temperature		Pressure, Lb./In.²			Volume		Density		Above 97.1° Btu./Lb. Heat Content				Entropy		
° F. T.	°Abs. T.	Ga. G.P.		Abs.	Liquid v	Vapor V	Liquid v	Vapor V	Liquid h	Latent L	Vapor H	u	e	Liquid s	Vapor S
97.1	557.1	0.0		14.7	.02625	5.5249	38.10	.181	.0	154.6	154.6	139.6	15.0	.0	.278
98	558	.3		15.0	.02629	5.3910	38.03	.189	0.5	154.4	154.9	139.4	15.0	.001	.278
100	560	.9		15.6	.02634	5.0761	37.96	.197	1.7	153.8	155.5	138.8	15.0	.003	.278
102	562	1.6		16.3	.02639	4.8781	37.89	.205	2.8	153.1	155.9	138.2	14.9	.005	.278
104	564	2.2		16.9	.02644	4.6948	37.82	.213	4.0	152.5	156.5	137.6	14.9	.007	.278
106	566	2.9		17.6	.02649	4.5249	37.75	.221	5.2	152.0	157.2	137.1	14.9	.009	.278
108	568	3.6		18.3	.02654	4.3860	37.68	.228	6.3	151.3	157.6	136.5	14.8	.011	.278
110	570	4.3		19.0	.02659	4.2373	37.61	.236	7.5	150.7	158.2	135.9	14.8	.013	.278
112	572	5.0		19.7	.02664	4.0984	37.54	.244	8.7	150.1	158.8	135.4	14.7	.015	.278
114	574	5.7		20.4	.02669	3.9841	37.47	.251	9.9	149.6	159.5	135.0	14.6	.017	.278
116	576	6.4		21.1	.02674	3.8610	37.39	.259	11.1	149.0	160.0	134.5	14.5	.019	.278
118	578	7.1		21.8	.02679	3.7594	37.32	.266	12.3	148.4	160.7	134.0	14.4	.021	.278
120	580	7.8		22.5	.02685	3.6496	37.25	.274	13.5	147.9	161.4	133.6	14.3	.023	.278
122	582	8.4		23.1	.02690	3.5587	37.18	.281	14.7	147.6	162.3	133.1	14.5	.025	.278
124	584	9.3		24.0	.02695	3.4364	37.10	.291	15.9	147.4	163.3	132.6	14.8	.027	.279
126	586	10.2		24.9	.02700	3.3113	37.03	.302	17.1	147.0	164.1	132.0	15.0	.029	.280
128	588	11.1		25.8	.02705	3.2051	36.96	.312	18.3	146.9	165.2	131.6	15.3	.031	.280
130	590	11.9		26.6	.02710	3.1056	36.88	.322	19.5	146.5	166.0	131.0	15.5	.033	.281
132	592	12.0		27.5	.02716	3.0030	36.80	.333	20.7	146.0	166.7	130.6	15.4	.035	.281
134	594	13.7		28.4	.02722	2.9155	36.73	.343	21.9	145.5	167.4	130.1	15.4	.037	.282
136	596	14.6		29.3	.02728	2.8329	36.65	.353	23.2	145.0	168.2	129.7	15.3	.039	.282
138	598	15.4		30.1	.02734	2.7473	36.58	.364	24.4	144.4	168.8	129.2	15.2	.041	.283
140	600	16.3		31.0	.02740	2.6738	36.50	.374	25.6	144.0	169.6	128.8	15.2	.043	.283
142	602	17.4		32.1	.02746	2.5840	36.43	.387	26.9	143.4	170.3	128.2	15.2	.045	.283
144	604	18.6		33.3	.02752	2.5000	36.36	.400	28.1	142.9	171.0	127.7	15.2	.046	.283
146	606	19.7		34.4	.02758	2.4155	36.27	.414	29.4	142.3	171.7	127.1	15.2	.048	.284
148	608	20.8		35.5	.02764	2.3419	36.20	.427	30.6	141.8	172.4	126.6	15.2	.050	.284
150	610	21.9		36.6	.02770	2.2737	36.12	.440	31.9	141.2	173.1	126.0	15.2	.052	.284
152	612	23.0		37.7	.02776	2.2075	36.05	.453	33.1	140.7	173.8	125.5	15.2	.054	.284
154	614	24.1		39.8	.02782	2.1459	35.97	.466	34.4	140.2	174.6	125.0	15.2	.056	.284
156	616	25.2		39.9	.02788	2.0833	35.89	.480	35.7	139.7	175.4	124.5	15.2	.058	.285
158	618	26.3		41.0	.02794	2.0284	35.81	.493	36.9	139.2	176.1	124.0	15.2	.060	.285
160	620	27.6		42.3	.02799	1.9685	35.73	.508	38.2	138.7	171.9	123.5	15.2	.062	.285
162	622	28.9		43.6	.02805	1.9084	35.65	.524	39.5	138.2	177.7	123.0	15.2	.064	.285
164	624	30.2		44.9	.02811	1.8553	35.58	.539	40.8	137.7	178.5	122.5	15.2	.066	.286
166	626	31.6		46.3	.02817	1.8051	35.50	.554	42.1	137.2	179.3	122.0	15.2	.067	.286
168	628	32.9		47.6	.02823	1.7544	35.42	.570	43.4	136.7	180.1	121.5	15.2	.069	.287

TABLE 1—Continued

Temperature		Pressure, Lb./In.²		Volume		Density		Above 97.1° Btu./Lb. Heat Content				Entropy		
° F. T.	°Abs. T.	Ga. G.P.	Abs.	Liquid v	Vapor V	Liquid v	Vapor V	Liquid h	Latent L	Vapor H	u	e	Liquid s	Vapor S
170	630	34.2	48.9	.02829	1.7094	35.34	.585	44.7	136.2	180.9	121.0	15.2	.071	.287
172	632	35.5	50.2	.02836	1.6667	35.25	.600	46.0	135.6	181.6	120.5	15.1	.073	.287
174	634	36.8	51.5	.02843	1.6260	35.17	.615	47.3	135.0	182.3	120.0	15.0	.075	.287
176	636	38.1	52.8	.02850	1.5873	35.19	.630	48.6	134.5	183.1	119.5	15.0	.076	.288
178	638	38.8	53.5	.02857	1.5408	35.01	.649	49.9	133.9	183.8	119.0	14.9	.078	.288
180	640	39.4	54.1	.02863	1.4448	34.93	.669	51.2	133.3	184.5	118.5	14.8	.080	.288
182	642	40.1	54.8	.02870	1.4535	34.85	.688	52.5	132.7	185.2	118.0	14.7	.082	.288
184	644	40.7	55.4	.02877	1.4124	34.76	.708	53.8	131.9	185.7	117.5	14.4	.084	.288
186	646	41.4	56.1	.02884	1.3735	34.68	.727	55.2	131.1	186.3	117.0	14.1	.085	.289
188	648	42.0	56.7	.02891	1.3405	34.60	.746	56.5	130.4	186.9	116.5	13.9	.087	.289
190	650	42.7	57.4	.02898	1.3055	34.51	.766	57.8	129.9	187.7	116.0	13.7	.089	.289
192	652	43.3	58.0	.02905	1.2723	34.43	.786	59.2	129.2	188.4	115.4	13.8	.091	.289
194	654	44.0	58.7	.02912	1.2422	34.34	.805	60.5	128.8	189.3	114.8	14.0	.093	.290
196	656	45.9	61.6	.02919	1.2092	34.26	.827	61.9	128.4	190.3	114.2	14.1	.094	.290
198	658	49.8	64.5	.02926	1.1779	34.17	.849	63.2	128.0	191.2	113.7	14.3	.096	.291
200	660	52.8	67.5	.02934	1.1481	34.08	.871	64.6	127.5	192.1	113.1	14.4	.098	.291
202	662	55.8	70.5	.02942	1.1198	33.99	.893	65.9	127.2	193.1	112.7	14.5	.100	.292
204	664	58.8	73.5	.02950	1.0929	33.91	.915	67.3	127.0	194.3	112.3	14.7	.102	.293
206	666	61.7	76.4	.02958	1.0672	33.82	.937	68.7	126.7	195.4	111.9	14.8	.103	.294
208	668	64.6	79.3	.02966	1.0428	33.73	.959	70.0	126.5	196.5	111.5	15.0	.105	.294
210	670	67.6	82.3	.02974	1.0204	33.64	.980	71.4	126.2	197.6	111.1	15.1	.107	.295
212	672	70.6	85.3	.02982	0.9804	33.55	1.02	72.8	125.5	198.3	110.4	15.1	.109	.295
214	674	72.9	87.6	.02990	0.9524	33.46	1.05	74.2	124.8	199.0	109.7	15.0	.111	.295
216	676	75.2	89.9	.02998	0.9346	33.37	1.07	75.6	124.0	199.6	109.0	15.0	.113	.296
218	678	77.5	92.2	.03006	0.9091	33.29	1.10	77.0	123.4	200.4	108.4	15.0	.114	.296
220	680	79.9	94.6	.03012	0.8850	33.20	1.13	78.4	122.6	201.0	107.6	15.0	.115	.296
222	682	82.2	96.9	.03021	.8696	33.11	1.15	79.8	122.1	201.9	107.1	15.0	.117	.296
224	684	84.5	99.2	.03030	.8475	33.02	1.18	81.2	121.5	202.7	106.5	15.0	.119	.297
226	686	86.8	101.5	.03039	.8264	32.93	1.21	82.6	121.0	203.6	106.0	15.0	.120	.297
228	688	89.1	103.8	.03048	.8130	32.84	1.23	84.0	120.5	204.5	105.5	15.0	.122	.298
230	690	91.4	106.1	.03057	.7937	32.75	1.26	85.4	120.0	205.4	105.0	15.0	.124	.298
232	692	94.1	108.8	.03066	.7752	32.65	1.29	86.8	119.4	206.2	104.4	15.0	.126	.298
234	694	96.8	111.5	.03075	.7576	32.55	1.32	88.2	118.7	206.9	103.8	14.9	.127	.298
236	696	99.6	114.3	.03084	.7353	32.46	1.36	89.7	118.1	207.8	103.2	14.9	.129	.299
238	698	102.3	117.0	.03093	.7194	32.36	1.39	91.1	117.3	208.4	102.5	14.8	.130	.299
240	700	105.0	119.7	.03100	.6993	32.26	1.43	92.5	111.7	209.2	101.9	14.8	.132	.299
242	702	107.7	122.4	.03110	.6849	32.17	1.46	94.0	115.2	210.2	101.4	14.8	.134	.299
244	704	110.4	125.1	.03120	.6711	32.07	1.49	95.4	115.7	211.1	100.9	14.8	.136	.300
246	706	113.1	127.8	.03130	.6536	31.97	1.53	96.9	115.1	212.0	100.4	14.7	.137	.300
248	708	115.7	130.4	.03140	.6410	31.87	1.56	98.3	114.6	212.9	99.9	14.7	.139	.301
250	710	118.7	133.4	.03150	.6250	31.76	1.60	99.8	114.1	213.9	99.4	14.7	.141	.301
252	712	121.8	136.5	.03160	.6098	31.66	1.64	101.2	113.3	214.5	98.7	14.6	.143	.301
254	714	125.0	139.7	.03170	.5952	31.55	1.68	102.7	112.5	215.2	97.9	14.6	.144	.301
256	716	128.1	142.8	.03180	.5814	31.45	1.72	104.2	111.7	215.9	97.2	14.5	.146	.302
258	718	131.2	145.9	.03190	.5650	31.35	1.77	105.6	110.9	216.5	96.5	14.4	.148	.302
260	720	134.3	149.0	.03201	.5525	31.24	1.81	107.1	110.0	217.1	95.7	14.3	.149	.302
262	722	137.4	152.1	.03213	.5405	31.14	1.85	108.6	109.1	217.7	94.9	14.2	.151	.303
264	724	140.5	155.2	.03225	.5291	31.03	1.89	110.1	108.3	218.4	94.1	14.2	.152	.304
266	726	143.7	158.4	.03237	.5181	30.93	1.93	111.6	107.4	219.0	93.3	14.1	.153	.304
268	728	147.3	162.0	.03249	.5025	30.81	1.99	113.1	106.6	219.7	92.5	14.1	.155	.205
270	730	150.9	165.6	.03261	.4902	30.70	2.04	114.6	105.7	220.3	91.7	14.0	.157	.306
272	732	154.6	169.3	.03273	.4785	30.58	2.09	116.1	105.2	221.3	91.3	13.9	.159	.305
274	734	158.3	173.0	.03285	.4651	30.46	2.15	117.6	104.7	222.3	90.9	13.8	.160	.305
276	736	161.9	176.6	.03297	.4545	30.34	3.20	119.1	104.3	223.4	90.5	13.8	.162	.304
278	738	165.6	180.3	.03309	.4444	30.22	2.25	120.6	103.8	224.4	90.1	13.7	.163	.303
280	740	169.3	184.0	.03319	.4329	30.10	2.31	122.1	103.1	225.4	89.7	13.6	.165	.302
282	742	173.0	187.7	.03333	.4237	30.09	2.36	123.6	102.3	225.9	88.8	13.5	.167	.302
284	744	176.7	191.4	.03347	.4149	29.87	2.41	125.1	101.2	226.3	87.8	13.4	.168	.303
286	746	180.8	195.5	.03361	.4032	29.74	2.48	126.7	100.3	227.0	86.9	13.4	.170	.303
288	748	184.9	199.6	.03375	.3937	29.62	2.54	128.2	99.3	227.5	86.0	13.3	.172	.304
290	750	189.0	203.7	.03389	.3846	29.49	2.60	129.7	98.2	227.9	85.0	13.2	.173	.304
292	752	190.2	207.9	.03404	.3759	29.36	2.66	131.3	97.4	228.7	84.3	13.1	.175	.304
294	754	197.3	212.0	.03419	.3676	29.24	2.72	132.8	96.7	229.5	83.6	13.1	.176	.304
296	756	201.4	216.1	.03434	.3584	29.11	2.79	134.4	95.9	230.3	82.9	13.0	.178	.305
298	758	205.5	220.2	.03449	.3509	28.99	2.85	135.9	95.1	231.0	82.2	12.9	.180	.305
300	760	209.6	224.3	.03465	.3436	28.86	2.91	137.5	94.3	231.8	81.5	12.8	.181	.305
302	762	216.7	228.4	.03483	.3367	28.73	2.97	139.0	93.4	232.4	80.7	12.7	.183	.305
304	764	217.5	232.2	.03501	.3279	28.59	3.05	140.6	92.4	233.0	79.9	12.5	.184	.305
306	766	221.3	236.0	.03519	.3195	28.44	3.13	142.2	91.5	233.7	79.1	12.4	.186	.305
308	768	225.1	239.8	.03537	.3115	28.30	3.21	143.7	90.6	234.3	78.3	12.3	.187	.305
310	770	228.9	243.6	.03552	.3040	28.15	3.29	145.3	89.6	234.9	77.5	12.1	.189	.305
312	772	232.8	247.5	.03570	.2967	28.00	3.37	146.9	89.0	235.9	77.0	12.0	.191	.305
314	774	236.6	251.3	.03588	.2899	27.86	3.45	148.5	88.2	236.7	76.4	11.8	.192	.305
316	776	240.4	255.1	.03606	.2833	27.71	3.53	150.1	87.6	237.7	75.9	11.7	.194	.306
318	778	244.2	258.9	.03624	.2770	27.57	3.61	151.7	86.8	238.5	75.3	11.5	.195	.307
320	780	248.0	262.7	.03647	.2710	27.42	3.69	153.3	86.1	239.4	74.7	11.4	.197	.307
322	782	254.3	269.0	.03676	.2639	27.26	3.79	154.9	84.9	239.8	73.6	11.3	.199	.307
324	784	260.6	275.3	.03699	.2571	27.10	3.89	156.5	83.6	240.1	72.4	11.2	.200	.306
326	786	267.1	281.8	.03722	.2503	23.94	3.99	158.1	82.4	240.5	71.2	11.2	.201	.306
328	788	273.4	288.1	.03745	.2445	26.78	4.09	159.7	81.1	240.8	70.0	11.1	.203	.305
330	790	279.9	294.6	.03768	.2387	26.62	4.19	161.3	79.8	241.1	68.8	11.0	.204	.305
332	792	286.3	301.0	.03791	.2331	26.45	4.29	162.9	78.6	241.5	67.7	10.9	.206	.305
334	794	292.8	307.5	.03824	.2278	26.29	4.39	164.5	77.3	241.8	66.6	10.7	.207	.305
336	796	299.2	313.9	.03847	.2227	26.13	4.49	166.2	76.1	242.3	65.5	10.6	.209	.304
338	798	305.4	320.1	.03860	.2179	25.97	4.59	167.8	74.9	242.7	64.4	10.5	.211	.304
340	800	311.3	326.0	.03880	.2114	25.77	4.73	169.4	73.7	243.1	63.3	10.4	.212	.304
342	802	317.3	332.0	.03415	.2053	25.57	4.87	171.1	72.5	243.6	62.3	10.2	.213	.304
344	804	323.1	337.8	.03950	.1196	24.36	5.01	172.7	71.2	243.9	61.2	10.0	.215	.304
346	806	329.0	343.7	.03985	.1942	24.16	5.15	174.4	69.9	244.3	60.1	9.8	.216	.303
348	808	334.9	349.6	.04020	.1894	24.95	5.28	176.0	68.7	244.7	59.0	9.7	.217	.303
350	810	340.9	355.6	.04055	.1845	24.75	5.42	177.7	67.4	245.1	57.9	9.5	.218	.303
352	812	346.8	361.5	.04091	.1799	24.54	5.56	179.3	65.7	245.0	56.4	9.3	.220	.302
354	814	352.8	367.5	.04127	.1754	24.34	5.70	181.0	63.9	244.9	54.9	9.0	.222	.301
356	816	358.6	373.3	.04163	.1715	24.13	5.83	182.7	62.2	244.9	53.4	8.8	.223	.300
358	818	365.3	380.0	.04199	.1647	23.87	6.07	184.3	60.4	244.7	51.9	8.5	.225	.299
360	820	372.3	387.0	.04235	.1587	23.61	6.30	186.0	58.6	244.6	50.3	8.3	.227	.298
362	822	379.3	394.0	.04286	.1531	23.35	6.53	187.7	56.6	244.3	48.8	7.8	.229	.297
364	824	386.0	400.7	.04337	.1477	23.09	6.77	189.4	54.5	243.9	47.3	7.2	.230	.296
366	826	393.0	407.7	.04388	.1429	22.82	7.00	191.1	52.4	243.5	45.8	6.6	.232	.295
368	828	399.9	414.6	.04439	.1383	22.55	7.23	192.8	50.3	243.1	44.3	6.0	.233	.293
370	830	406.8	421.5	.04490	.1340	22.29	7.46	194.5	48.2	242.7	42.8	5.4	.235	.292
372	832	413.7	428.4	.04541	.1300	22.02	7.69	196.2	43.4	239.6	38.5	4.9	.237	.288
374	834	420.5	435.2	.04757	.1263	21.75	7.92	197.9	38.7	236.6	34.2	4.5	.238	.283
376	836	427.8	442 5	.04973	.1117	20.67	8.95	199.6	33.7	233.3	29.7	4.0	.239	.279
378	838	435.3	450.0	.05189	.1000	19.60	10.00	201.3	29.0	230.3	25.4	3.6	.241	.275
380	840	442.9	457.6	.05405	.0909	18.50	11.00	203.0	24.0	227.0	20.9	3.1	.242	.270
382	842	445.5	460.2	.05811	.0833	17.35	12.00	204.7	17.2	221.9	15.0	2.2	.244	.266
384	844	457.5	472.2	.06217	.0768	16.22	13.00	206.4	9.5	215.9	8.2	1.3	.225	.261
386	846	466.6	481.3	.06623	.0714	15.10	14.00	208.2	3.6	211.8	3.1	0.5	.246	.254
387	847	470.7	485.4	.06900	.0690	14.50	14.50	209.0	0	209.0	0	0.0	.247	.247

Novel Blowdown System At British-American Refinery

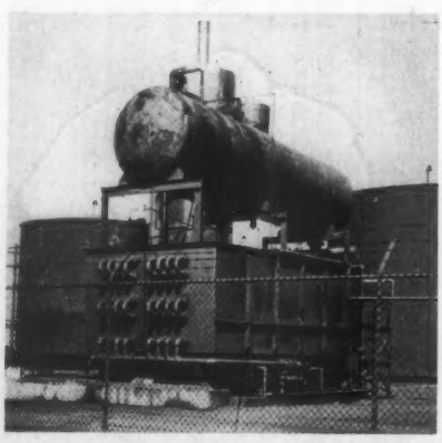
A SERVICEABLE unit was designed by engineers in British-American Oil Company at Toronto, Canada, for blowing down the cracking unit. When the plant was built, provisions for blowing down the cracking unit were not made so that the residue of processing, and the lighter fractions could be salvaged intact, much less separated in a clean, usable condition without reprocessing, or throwing the entire mass into slops, or inferior fuel oil.

Considerable study was made prior to the erection of the present unit, because it was desirable that no material was to be used which could not be taken from the scrap pile, the idle material yard, or warehouse stocks. The plant is outside the main part of Toronto, and adjacent to Kingshighway No. 2, which traverses the Province of Ontario from Detroit to the province line separating Quebec from Ontario. Two reasons were therefore uppermost in the minds of the management, as well as the engineers responsible for the unit, one to conserve valuable material which formerly went to waste, and the other was to prevent obnoxious vapors and odors from annoying the neighborhood.

In the new unit, a concrete sump was poured, containing three divisions, made by running walls through the sump, as is usually done with water and oil separating tanks. The outside walls of this sump were constructed heavy enough to support other equipment to be erected above the pits.

A discarded condenser box was next erected, which had been used in a previously operated skimming unit, having 40 rows of three-inch tubes placed lengthwise, with the return bends connected to the tubes on the outside of the condenser box. These tubes were placed so that there are eight rows in five banks, connected at the upper end on one side to a header. Upon a steel superstructure, an obsolete tank car shell was mounted, with a four-inch pipe connection welded to the lower side near the end. Flanged connections were used to connect this outlet to the header attached to the upper row of tubes. The dome cover was worked over so a tight fit could be secured, which would not become loosened when subjected to the stresses encountered while blowing down the cracking unit.

The old blowdown line was securely connected to the tank car shell, at the same end to which the tube header was bolted, and a six-inch vapor line was flanged to a connection made on one side of the dome. This vapor line, which carries the lighter fractions from the blowdown material, was run over to one side, leading downward and connected through a bolted flange connection to a vertical column. This salvaged vessel was placed on concrete supports, and the six-inch vapor line was connected to it at a point about midway of its height. The vessel also has a vent line to the atmosphere, running from the upper head, and was fitted with a spider inside, and near the top head, through which water in a dense spray can be introduced for cooling and condensing. The water line enters through the side of the vessel, and the water used is supplied by a pump set aside for this purpose. It is not used except when the plant is brought off steam for a clean-out.



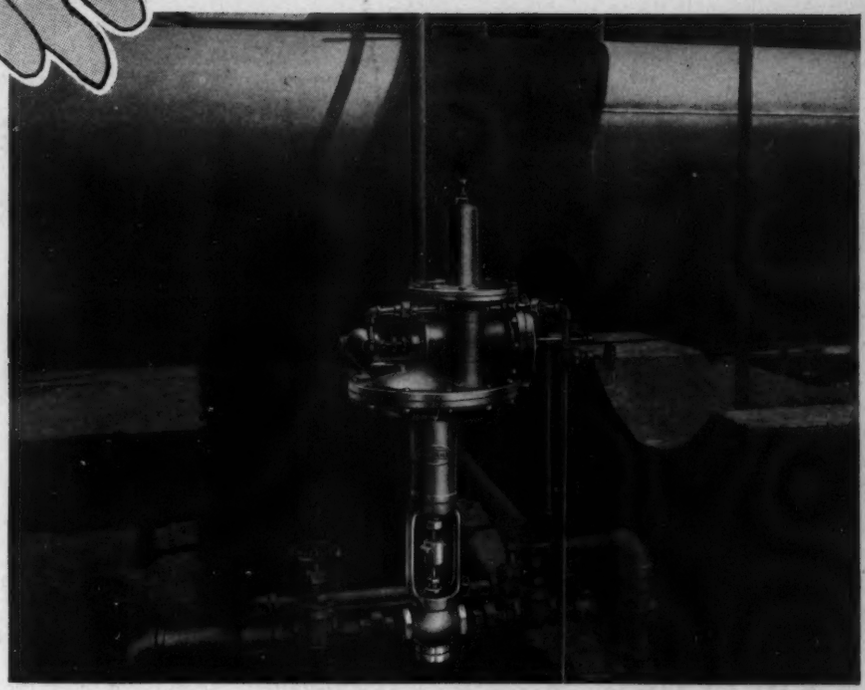
Blowdown apparatus in plant of British-American Oil Company, Toronto, Can.

The lower opening in the vertical vessel is just above the first of the series of separating pits in the sump, and the entire unit is operated on atmospheric pressure, without a block valve or other regulating device inserted in the line of flow. When the unit is in operation, the regular procedure used in blowing down the cracking unit is employed, except that the water pump is started soon enough prior to this operation that a stream of water is running through the vertical vessel. The mass of material contained in the cracker is vented directly to the shell of the tank car, with the heavier material becoming liquid upon entering, flowing through the series of condensing coils, and becoming cool enough for storing as it leaves the last and lower bank of coils in the condenser box. The lighter vapors, gas oil, cracked stocks, recycle, etc., in the cracking unit and transferred to the separating unit through the blowdown line, leave the tank car shell as vapors, coming to the liquid state under reduced pressure.

These vapors enter the side of the vertical column, and those which may be condensed fall to the sump through the bottom outlet of the vessel. Others, yet in vapor form, rise and come into contact with the dense spray of water falling through the hollow shell, and are condensed to liquids. Steam is vented through the stack on the top of the vertical column. The cooled, heavy oil flows from the coils in the condenser box and is pumped to fuel oil storage. While the water and condensed lighter vapors fall from the bottom of the vertical vessel, separation is effected in the first compartment of the sump, and the oil rises to the top without being emulsified. The use of the succeeding compartments is for complete skimming of water, and the action of these are familiar to all refiners. Oil is skimmed from all compartments except the last one, which is devoid of oil film, and the water runs to waste. The quality of the skimmed oils from the sump is such that it can be thrown back into cracking charge without treating.

Put the Bracelets on unruly pressures

with MASON-NEILAN 27's



If you want to lay down the law to your reduced pressures, the Mason-Neilan No. 27 is the regulator for the job. On your toughest hard-boiled service—high pressure gas lines and main steam headers—on make-up or back pressure systems—wherever pressures are high and volumes vary greatly, you can depend on this pilot-operated regulator for a constant pressure supply.

The No. 27 has multiple springs that permit the use of larger diaphragms—stainless steel ball bearings that allow full floating action for the diaphragm plunger and valve stems—centroguide valves that reduce flow turbulence and wire drawing—supersensitive pilot valve that may be operated by gas, air or water—non-corrosive working parts and many other features that insure accurate, economical and dependable service.

And in addition to accuracy and dependability, the No. 27 gives you flexibility. You can easily change its pressure range or convert it into a back pressure regulator for your stabilizers, reflux accumulators, absorbers or pressure chambers.

No job is too tough for the No. 27. Use it when you want results. Send for bulletin. No obligation.

MASON-NEILAN REGULATOR CO., 1190 ADAMS ST., BOSTON, MASS.

MASON-NEILAN

PRESSURE • TEMPERATURE • FLOW CONTROL

Here is low-cost VACUUM

ELLIOTT Steam Jet AIR EJECTORS. . . .

with no mechanical movement, no wear, no lubrication, practically no attention, are faithfully providing required vacuum in hundreds of refineries for distillation and fractionating processes.

Applied with the wealth of experience gained by Elliott engineers, this vacuum equipment is invariably successful. The equipment is always designed for the specific job, falling in step with the conditions it is built to meet, and operating dependably and economically wherever installed.

The experience of Elliott Company is at your service. Call upon it—write us today.

BULLETIN G-6 JUST PUBLISHED

covers every angle of vacuum production with steam jet ejectors. Every refinery engineer and executive will find it valuable. Write for a copy.

ELLIOTT COMPANY

PITTSBURGH, PA.

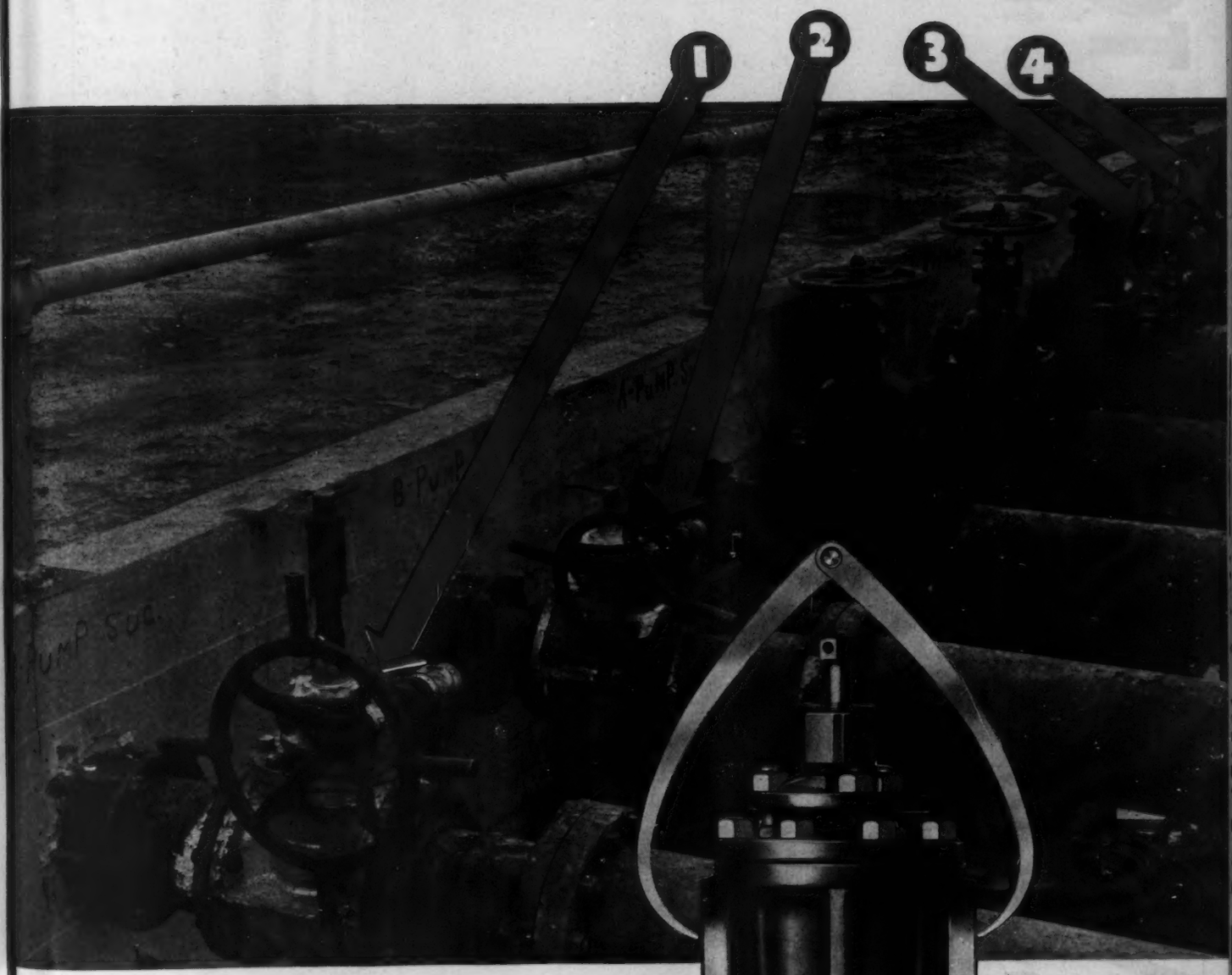
Heat Transfer Department JEANNETTE, PA.

District Offices in Principal Cities

PIONEERS IN THE DESIGN, CONSTRUCTION AND APPLICATION OF STEAM JET EJECTORS

G-333a

THESE 4 EMCO-NORDSTROMS ARE REPLACEMENT VALVES



. . . the Photo tells its story

Four Emco-Nordstroms replaced gate valves on these intake lines from main line to main line pumping station of a Texas pipe-line company. The first two valves are on blocking-off manifold and last two valves are on gathering lines from field. 6" and 8" sizes.

DIMENSIONS SAME GATE VALVES, FA TO-FACE

In making replacements valves no change is nec sary in the pipe arran ment. Simply unbolt the valve and install the Em Nordstrom. You save t and future expense.

NORDSTROM VALVES

. . . . WITH PATENTE "SEALDPORT" LUBRICATI

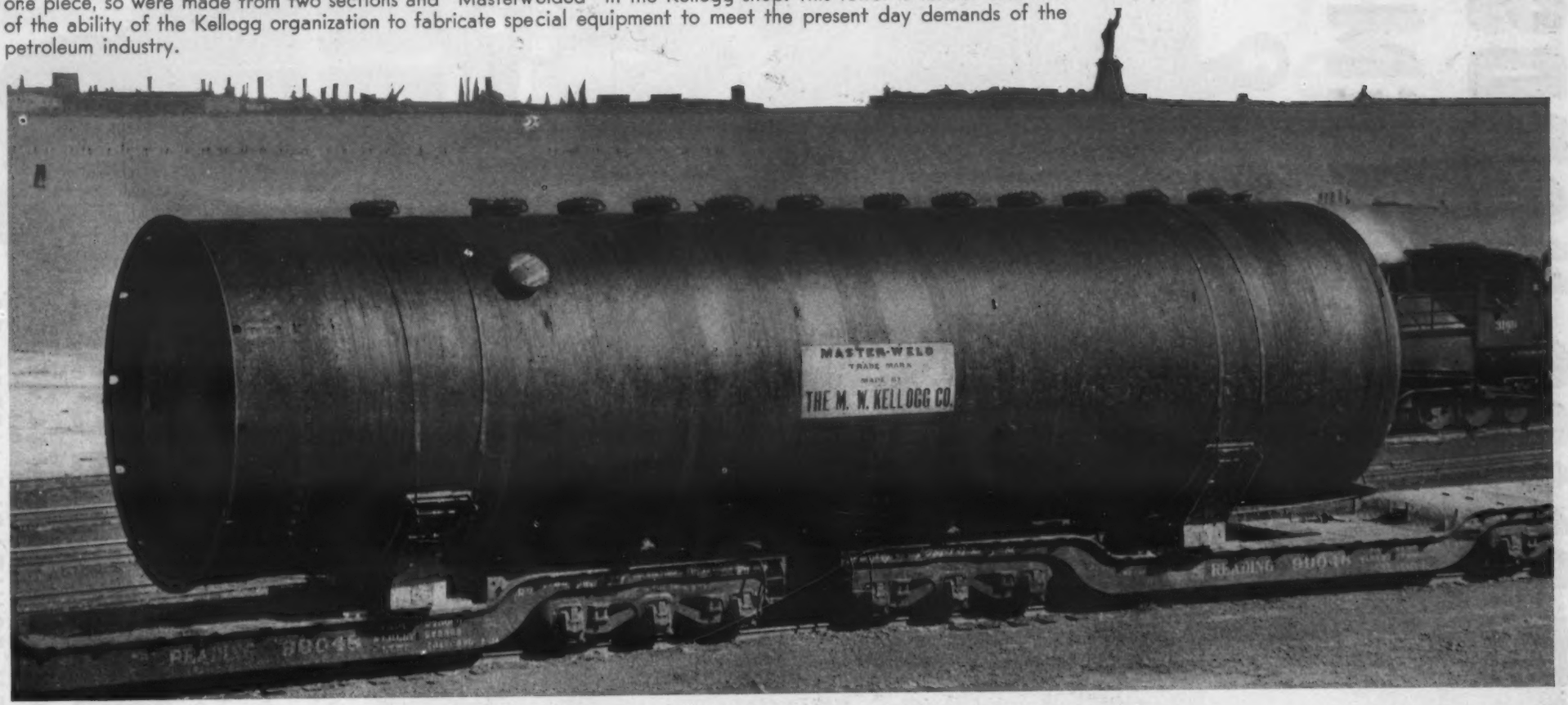
EMCO NORDSTROM VALVE CO.
A Subsidiary of
PITTSBURGH EQUITABLE METER CO.

Main Offices: Pittsburgh, Penna. *Branch Offices:* New York City, Buffalo, Philadelphia, Columbia, Memphis, Atlanta, Chicago, Kansas City, Tulsa, Houston, Los Angeles and Oakland.

150 TON KELLOGG FLASH TOWER

16 ft. in diameter by 67 ft. long overall—1 in. thick

This is one of the largest vessels ever shop fabricated for shipment to a distant point. Each section is made from a single carbon steel plate one inch thick, 10 feet in width and 50 feet 6 inches long, containing over 500 square feet of area. This is the largest surface area ever rolled. The heads are so large they could not be flanged or dished in one piece, so were made from two sections and "Masterwelded" in the Kellogg shop. This tower is further evidence of the ability of the Kellogg organization to fabricate special equipment to meet the present day demands of the petroleum industry.



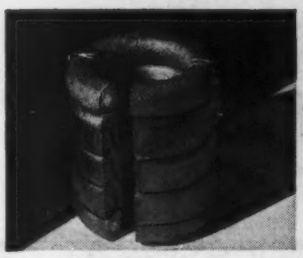
THE M. W. KELLOGG COMPANY, JERSEY CITY, NEW JERSEY
225 BROADWAY, NEW YORK

LOS ANGELES: 1031 SOUTH BROADWAY—BIRMINGHAM: 827 BROWN-MARX BUILDING—HOUSTON, TEXAS—TULSA: PHILTOWER BUILDING

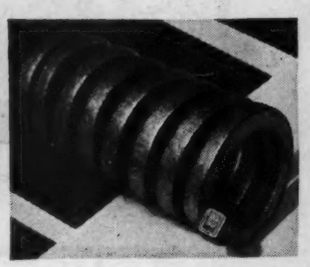
JM PACKINGS

The Right Packing in the Right Place

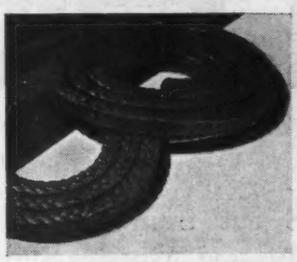
IF one of the seven famous J-M Packings shown below won't solve your packing problem, then one of the 92 others included in the J-M Packing Catalog will. Free to any user of packings, this new catalog also contains a complete recommendation table based on Johns-Manville's 60 years of packing experience. Mail the coupon.



J-M Sea Rings. Absolutely automatic. Save power. Reduce wear on equipment. Last longer.



J-M Kearsarge Rod Packing. Retains its efficiency—note construction of center block.



J-M Centripac. Plaited construction. Specially designed for centrifugal service.

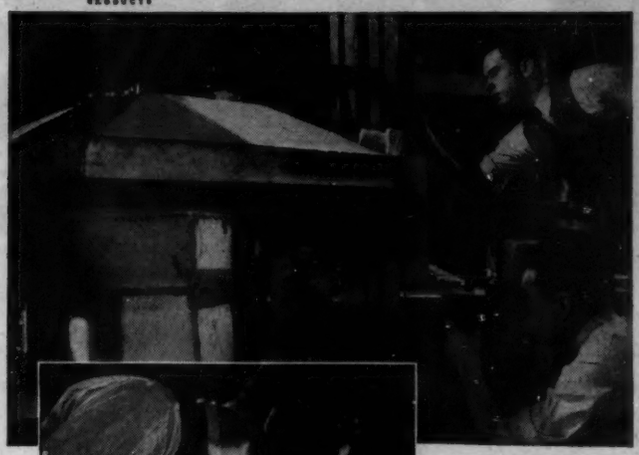
J-M Flax Packings in various styles to meet a wide variety of service conditions.

J-M Kearsarge Boiler Gaskets assure a perfect seal on handholes, manholes, tube plates.

J-M Service Sheet. Pliable. Resilient. Adaptable to all general sheet packing purposes.

(center) J-M Mogul Packing. An excellent utility packing for general service.

JM REFRACTORIES



A refractory under fire! Taking temperature and deformation readings on A.S.T.M. load-test furnace in the J-M Laboratories.

Not flame but white heat! J-M engineer determining softening point of a refractory in an electric induction furnace.

They're solving your Refractory Cement Problems

A REFRACTORY cement problem? Talk it over with the Johns-Manville Sales Engineer. You'll find his advice thoroughly sound, his recommendations decidedly helpful.

For he brings to your problem a fund of expert knowledge built up by a quarter century of intensive research.

Some twenty-five years ago, Johns-Manville engineers produced the first bonding mortar cement. In 1935, still pioneering, the J-M Laboratory perfected Light Weight Firecrete, a revolutionary new hydraulic cement for casting lightweight monolithic refractory concrete.

May we bring you up to date on recent J-M developments? Mail the coupon for the J-M Refractory Cements Data Sheet Brochure.

Johns-Manville

Check service desired, fill in balance of coupon and return to Johns-Manville, 22 E. 40th Street, N. Y. C.

Send us a copy of

- ☐ Johns-Manville Packings Catalog.
- ☐ Johns-Manville Refractory Cements Data Sheet Brochure.

Name_____ Title_____

Firm Name_____

Address_____

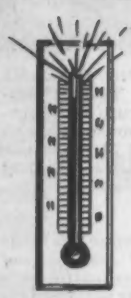
City_____ State_____

RNG-12-35

GARLOCK 7021

COMPRESSED ASBESTOS GASKET SHEET

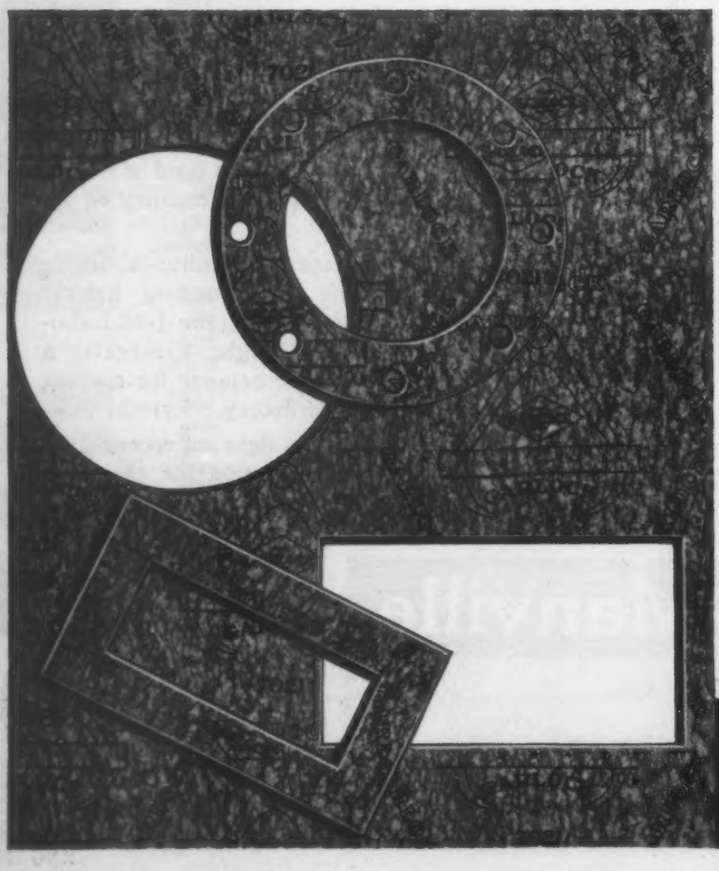
for



HIGH TEMPERATURES

EXTREME PRESSURES

GASOLINE | **OIL** | **GAS** | **STEAM**



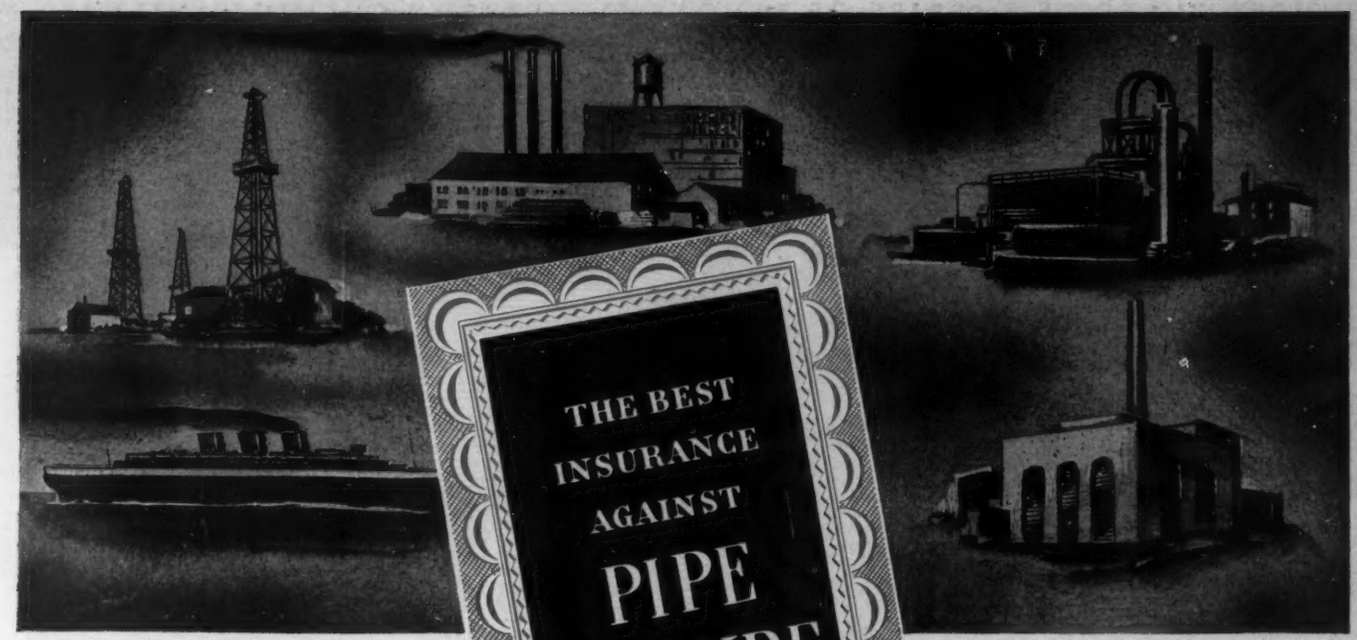
GASKETS cut from GARLOCK 7021 Compressed Asbestos Sheet give exceptional service on pipe lines and other equipment handling gasoline, oil, gas or steam at high temperatures and extreme pressures. Tough, yet resilient—GARLOCK 7021 is particularly economical and efficient for severe conditions.

THE GARLOCK PACKING COMPANY
Palmyra, New York

In Canada:
The Garlock Packing Co. of Canada, Limited,
Montreal, Que.

TULSA, OKLAHOMA HOUSTON, TEXAS
LOS ANGELES, CALIFORNIA

GARLOCK



No one objects to paying 25 cents for a half-dozen razor blades, even though it is common knowledge that the steel in those blades costs in ingot form only an infinitesimal fraction of a cent. Why?

Those blades do what the steel in the ingot could not do before work was done on it. You pay for the service the steel has been processed to do.

It's the same with Toncan Iron Pipe. Open hearth iron has been alloyed with copper and molybdenum and processed to resist corrosion—and it does to a greater degree than any other ferrous material in its price class. Naturally, it costs more than ordinary pipe, but don't figure it that way. Figure the slight additional cost of the pipe itself as insurance against pipe failure. Then you will quickly realize how slight a premium you are paying for long dependable service—how little you are paying to cut down repair and replacement expense. And don't forget that it costs more to tear out failed pipe and replace it with new than it costs to make the original pipe installation. So the smart thing to do is to install Toncan Copper Molybdenum Iron Pipe in the first place and save money.

REG. U.S. PAT. OFF.
TONCAN
COPPER
MO-LYB-DEN-UM
IRON PIPE

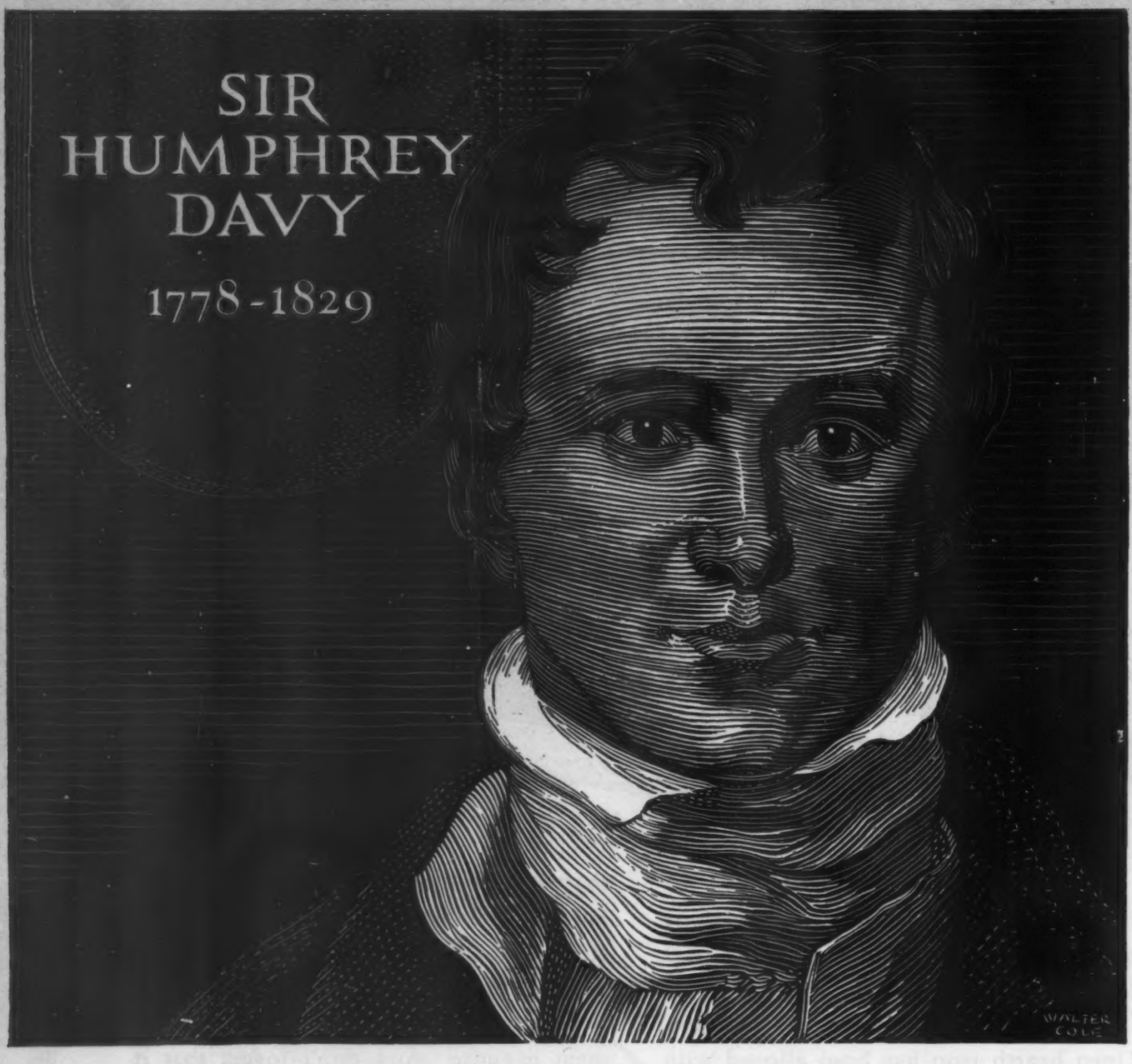
REPUBLIC STEEL

Republic Steel
CORPORATION
GENERAL OFFICES · · · YOUNGSTOWN, OHIO

NUMBER THREE OF A SERIES OF FAMOUS PIONEERS IN CHEMICAL HISTORY

SIR HUMPHREY DAVY

1778-1829



Apprenticed to a surgeon and apothecary at the age of fifteen, Davy was appointed to the Royal Institution in 1801 at the age of twenty-three and was knighted eleven years later. His health failed, however, while he was still at the height of his career and he died in 1829 at 51. Davy is said to have been one of the first to use the electric current for thorough and fundamental chemical investigation.

IN 1807 fashionable London paid twenty pounds a head to watch Sir Humphrey Davy at the Royal Institution perform the miracle of the age—to see him produce small quantities of metallic sodium by means of a new-fangled electrical apparatus. Davy's epoch-making discovery and his pioneer work with Faraday in experimental electricity marked the beginning of the modern electrolytic process for manufacturing caustic soda. Mathieson, pioneer producer of high purity caustic soda both by the electrolytic and ammonia-soda processes, has also pioneered the distribution of caustic soda in liquid form to large consumers. Mathieson Caustic Soda is now supplied to industry from three strategically-located producing points — Saltville, Va., Niagara Falls, N. Y. and Lake Charles, La.

The MATHIESON ALKALI WORKS (*Inc.*), 60 East 42nd St., New York, N.Y.

SODA ASH . . . CAUSTIC SODA . . . BICARBONATE OF SODA . . . LIQUID CHLORINE . . . BLEACHING POWDER . . . HTH AND HTH-15 . . .

Mathieson Chemicals

AMMONIA, ANHYDROUS AND AQUA . . . PH-PLUS (FUSED ALKALI) . . . SOLID CARBON DIOXIDE . . . CCH (INDUSTRIAL HYPOCHLORITE)

"TUNE IN" To Process Control

PROCESS LAG ... CAPACITY LAG ... THRUPUT CHANGES

. . . . as Easily as dialing a Radio

BROWN Air-O-Line

Easily Adapted Then Fully Automatic

AUTOMATIC RESET DIA
The graduated dial mak it possible to change th rate at which the contr point is automatically r set. No resistance tubin is used.

THROTTLING RANGE DIA
Graduated from 1 per cen to 150 per cent throttlin range. Sufficient to pr vide flexibility required t meet any type of contr problem.
Instantly adjustable wit out removing chart plat

Other features and mode are fully described i Catalog 8900. Write for i

The use of Graduated Dials for both "*Throttling Range and Automatic Reset*" in the Brown *AIR-o-LINE* is a revolutionary development in air operated controllers. They provide a means for "tuning in" to your specific process requirements, simply and quickly, without dismantling the controller or interrupting its control operation. Operators are encouraged to secure "best possible," not just "good enough," control results, so apt to be present where adjustments are complicated and time-consuming.

Brown *AIR-o-LINE* assures accurate measurement and precise control of temperatures, pressure, flow and liquid level—*AIR-o-LINE* is set with the same simplicity as dialing a radio—once it is "tuned in" it becomes fully automatic. Brown *AIR-o-LINE* not only confines the process within limits but it "lines out" control at the exact desired control point, regardless of load or thruput changes.

Brown *AIR-o-LINE* has everything you have wished for in air operated control—it "Recognizes," "Analyzes" and "Corrects" for any departure from the exact control setting—without "Cycling," "Drifting" or shifting of the control point.

Modernize your process control with this MODERN air operated instrument. Brown *AIR-o-LINE* is more than a controller—it's a system that will aid you to reduce costs—designed for outstanding performance with simplicity.

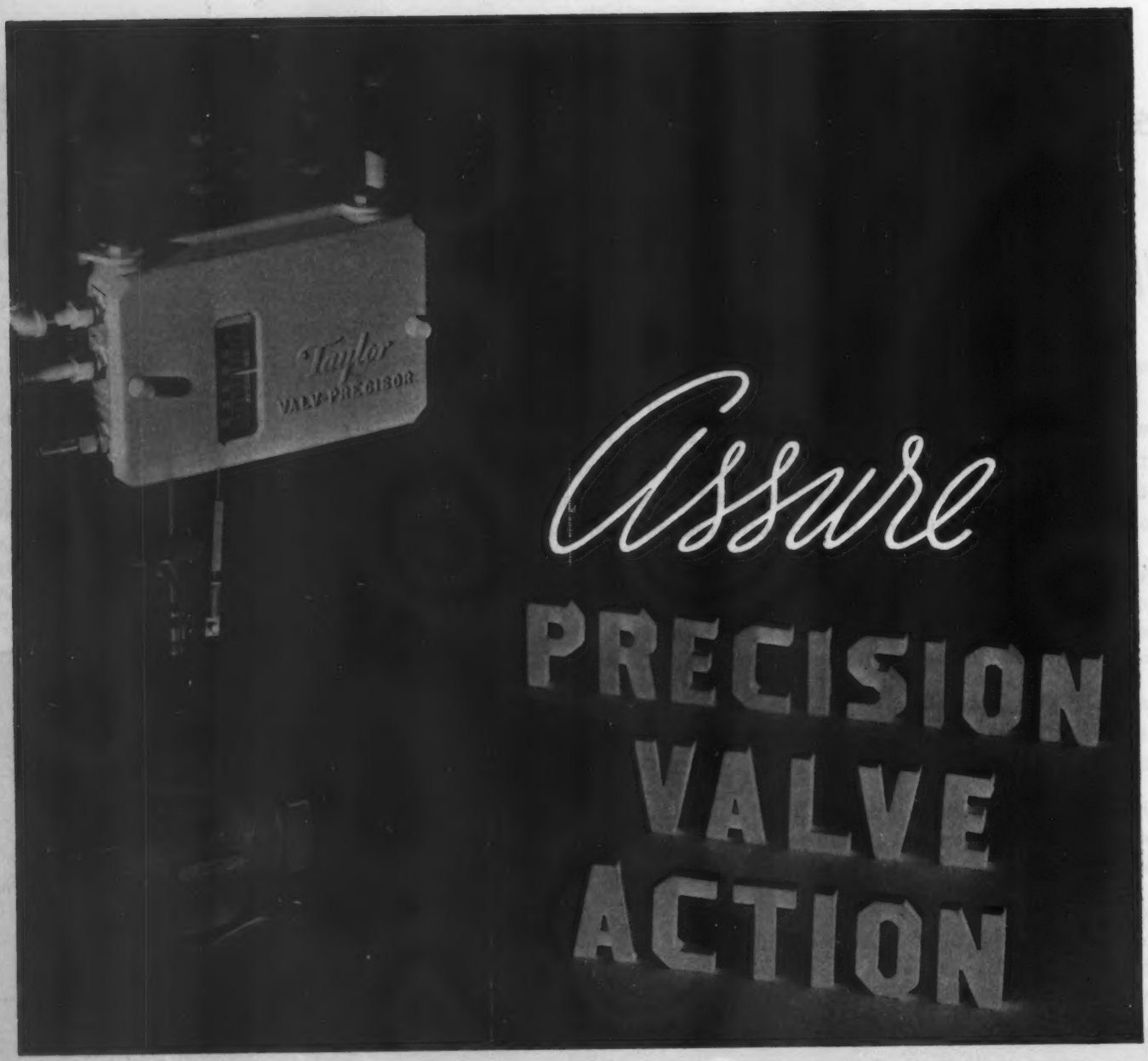
Learn more about Brown *AIR-o-LINE*—you can rely on its accuracy—be confident of its dependability. Write for Catalog No. 8900. BROWN INSTRUMENTS, a division of Minneapolis-Honeywell Regulator Co., 4498 Wayne Avenue, Philadelphia. Offices in all principal cities. Canadian Factory, 117 Peter Street, Toronto, Canada.

BROWN
Air Operated
CONTROLLERS
Air-o-Line

BROWN AIR OPERATED CONTROLLERS

OUTSTANDING PERFORMANCE WITH SIMPLICITY

MODERNIZE



.... BRING YOUR PRESENT CONTROL VALVES UP TO DATE

...with the new Taylor "Valv-Precisor"

With this recent development, Taylor can now supply a Unit or a System for every temperature, pressure, flow or liquid level control condition in a refinery

Regardless of valve-stem friction—

Regardless of diaphragm-motor hysteresis (friction and lost motion), most frequently found in motors of older design—

Regardless of the things in your present valves that prevent efficient valve action—

The New Taylor Valv-Precisor can now provide precision control.

Thus, Taylor Engineering enables you to modernize your present control equipment, and increase the efficiency of your oldest valves to a most remarkable degree. The Taylor Valv-Precisor can be used in conjunction with the air-operated controller and mounted on the diaphragm valve you have now.

It is designed especially for the numerous low-sensitivity processes where load changes are not important, but where there are long, unfavorable time lags. The Valv-Precisor has a place between the Taylor Fulscope with single response and no precision valve action, and the Taylor "Dubl-Response" Control System, which accurately compensates for large load changes despite long time lags and supplies Precision Valve Action.

This new Control Unit is simple, and sturdy in construction. It is housed in a weatherproof and non-corrosive case. It has only one adjustment, easily made with a screw driver. The Valve Position Indicator is safe against the weather and clearly visible. The air-system is economical and foolproof.

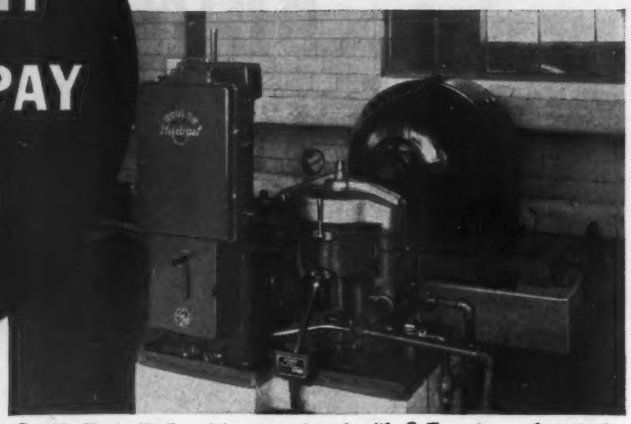
Let a Taylor Representative discuss with you the application of the Valve-Precisor to improve your control of temperature, pressure, rate of flow, or liquid level. Address Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada. Manufacturers in Great Britain—Short & Mason, Ltd., London, England.

Taylor

Indicating | Recording • Controlling

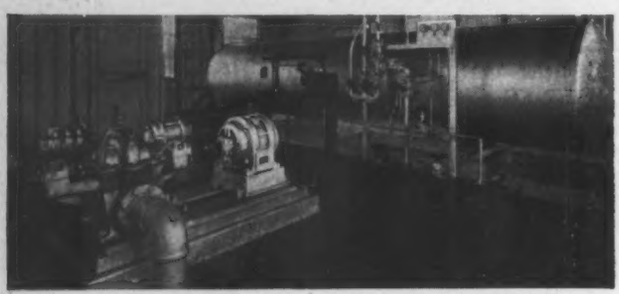
TEMPERATURE, PRESSURE and FLOW INSTRUMENTS

FOUR REASONS WHY G-E MOTORS PAY DIVIDENDS

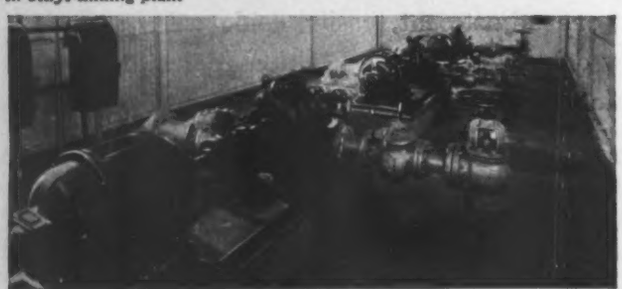


Goulds Hydroil oil reclaimer, equipped with G-E motor and control, at pipe-line station. G-E Type CD direct-current motor, with top-half cover, in the background

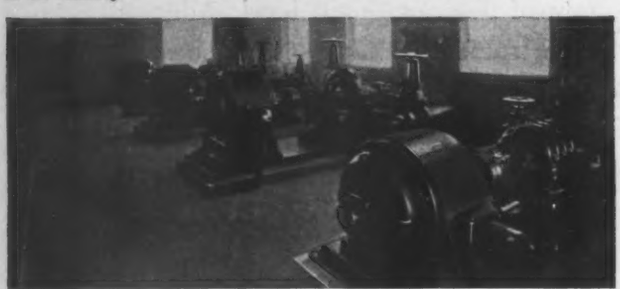
G-E squirrel cage induction motors driving pumps installed in oil refinery



G-E squirrel cage induction motors direct-coupled to gasoline pumps in ethyl-mixing plant



G-E induction motors driving single and multistage centrifugal pumps in oil refinery



G-E induction motors direct-coupled to multistage centrifugal pumps

1. **Designed to meet the conditions of the oil industry.**
2. **Long life and economical operation.**
3. **Motors backed by many years of manufacturing experience.**
4. **Quick service assured at all times by our nation-wide distribution facilities.**

The illustrations show important installations which are completely G-E driven and controlled.

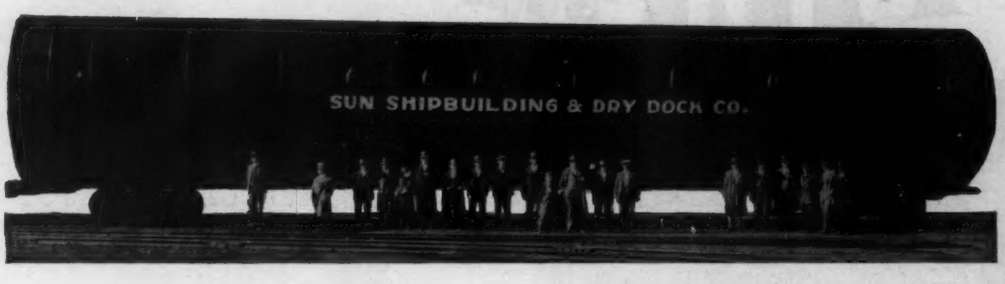
General Electric supplies complete equipment to the oil industry—motors of all types; power and distribution transformers of various capacities; Glyptal cable that is impervious to greases and oils; generators for Diesel engines; turbine-generator sets; and a wide variety of time- and labor-saving devices.

Further information may be obtained from any G-E sales office, or from the General Electric Company, Schenectady, N. Y.

020-215

GENERAL ELECTRIC

Class I Welded Vessels



CLASS I WELDED VESSEL
Stress Relieved in One Piece.
X-rayed 100%

FRACTIONATING TOWER
14 ft. 8¾ ins. Outside Dia. x 83 ft. High
Wt. 270,000 lbs.

Capacity for massive construction » on a quantity basis

PRODUCTS

ASME Class I Welded Vessels
Towers and Tanks, Riveted or Welded
Agitators
Absorbers
Condenser Boxes
Heat Exchangers
Pressure Vessels
Stills
Still Bottoms
Fabricated Plate Work
Special Machinery
Angle Bending
Any Special Equipment for Refineries

FACILITIES

X-ray Equipment
Stress Relieving Furnace for towers up to 17 feet diameter, any length
Metallurgical Laboratory
Tank Shop
Steel Shop
Foundry
Complete Machinery Plant
Complete service for building made-to-order equipment. All-welded or riveted vessels
Chrome-Nickel and Alloy Welding and Machining
Rail or Water Shipments

For many years this Company has utilized the facilities of this great Ship and Engine building plant for constructing refinery equipment and other made to order or special equipment. These facilities are being constantly improved. Large Stress Relieving Furnace, X-ray Machinery and all facilities for Class I Pressure Vessels are now in use.

These unlimited facilities are for your service.

SUN
SHIPBUILDING & DRY DOCK COMPANY
CHESTER, PA.

SOUTHERN ALKALI

SODA ASH
CAUSTIC SODA
LIQUID CAUSTIC
MODIFIED SODAS
CAUSTIC ASH

THE CORPUS CHRISTI PLANT of the SOUTHERN ALKALI CORPORATION has Established a Reputation for Prompt, Dependable Service

Refineries located in the Southwest and along the Atlantic and Pacific Coasts have learned from experience that they can depend on the Corpus Christi plant of the Southern Alkali Corporation for prompt delivery of alkali products with definite standards of quality, uniformity and purity. Added to quality and dependability this plant offers refiners:

QUICK DELIVERIES—*now a matter of hours rather than days.*
SHORT-HAUL LOW COST TRANSPORTATION—*tidewater or rail shipments.*

Southwestern refiners can now purchase liquid caustic soda in tank cars at both 50% and 70% strength—an economical advantage never before available to them.

A letter, wire or phone call to the office most convenient to you will bring full information regarding the various alkali products manufactured at Corpus Christi.

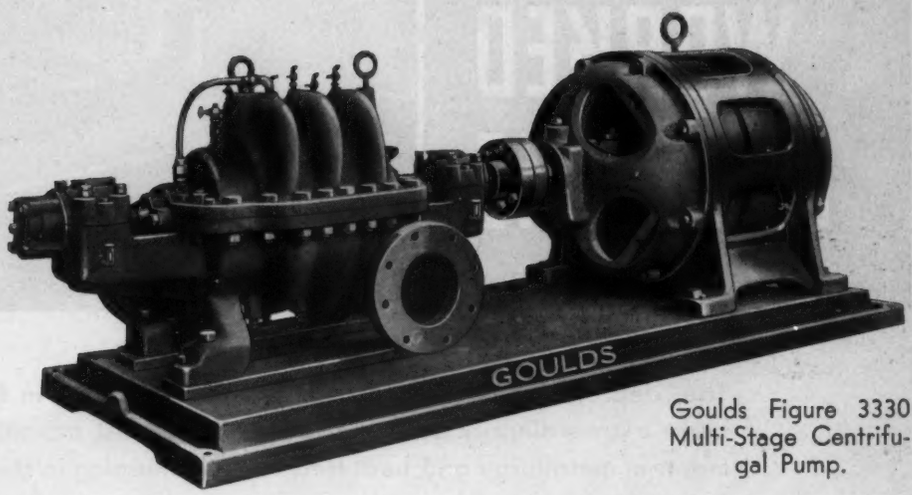
• SOUTHERN ALKALI CORPORATION •

30 ROCKEFELLER PLAZA, NEW YORK, N. Y. CORPUS CHRISTI, TEXAS
SANTA FE TERMINAL BUILDING, DALLAS, TEXAS.

45 places

ACID
ASPHALT
BILGE
BOILER FEED
BOOSTER
BRINE
BULK & SERVICE STATION
CENTRIFUGAL
CHARGING
CIRCULATING
CONDENSATE RETURN
DEEP-WELL
DRAINAGE
DRIP
DUPLEX
FRACTIONING
GASOLINE
GEAR
HAND PUMPING
HIGH PRESSURE
HOT OIL
HYDRAULIC
INVERTO TOWER
LIGHT SERVICE
LOADING AND UNLOADING
LUBRICATING
MINE
MULTI-STAGE
PIPE LINE
PLUNGER
PROPANE
RECIPROCATING
ROTARY
SHELL STILL
SLUDGE
SUMP
TANK
TAR
TEST
TRANSFER
TRIPLEX
TURBINE TYPE
UNDERWRITERS FIRE
VOLATILE LIQUID
SPECIAL

WHERE GOULDS DEPENDABILITY CUTS YOUR PUMPING COSTS



Goulds Figure 3330 Multi-Stage Centrifugal Pump.

Goulds pumps have long been an important part of oil production and refinery operations — The reason is "Dependability."

Whether on hot or cold oil work — or on the dozens of miscellaneous uses that require the movement of liquids — Goulds Pumps have made good. Their reliability is due to extra strength parts and design based on intimate knowledge of oil requirements.

In building to the special needs of the oil industry, Goulds have left nothing to chance. The finest of materials, searching inspections, and rigid adherence to quality workmanship — give you the finest pumps money can buy — guard and maintain the Goulds reputation for quality.

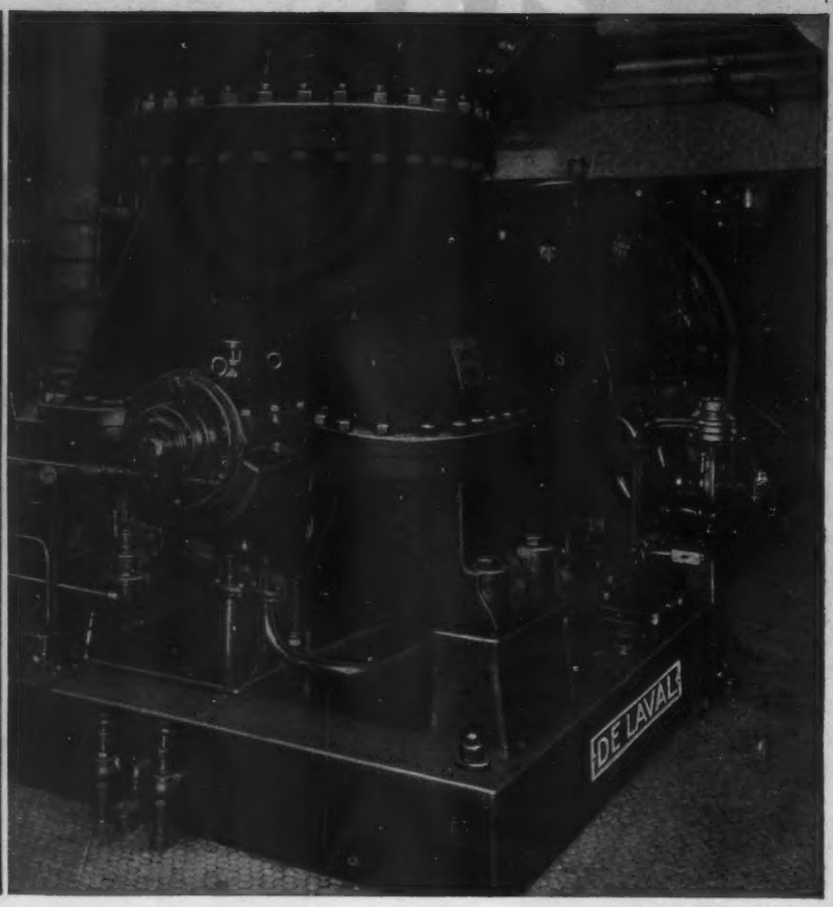
THERE IS A GOULDS PUMP FOR EVERY PURPOSE IN THE FIELD, IN THE REFINERY AND ON THE PIPE LI

GOULDS PUMPS Inc

SENECA FALLS N. Y.

ATLANTA, BOSTON, CHICAGO, HOUSTON, NEW YORK, PHILADELPHIA, PITTSBURGH, TULSA, Representatives in all Principal Ci

OUR TURBINE DESIGNERS *have* WORKED FULL TIME



The "depression" has been no period of relaxation; in fact, our Engineers have been extraordinarily active in taking the utmost advantage of recent improvements in metallurgy and heat treatment, in keeping in step with progress towards higher steam pressures and temperatures, in stream-lining steam passages, and in improving governing devices, all in order to make the present day

DE LAVAL STEAM TURBINES

so much more efficient and less expensive to operate that owners would be compelled to replace older power apparatus with improved De Laval equipment.

The use of higher steam pressures and temperatures, in particular, offers great economies and where existing low pressure equipment is of an efficient type it can frequently be utilized by super-imposing high pressure boilers and turbines.

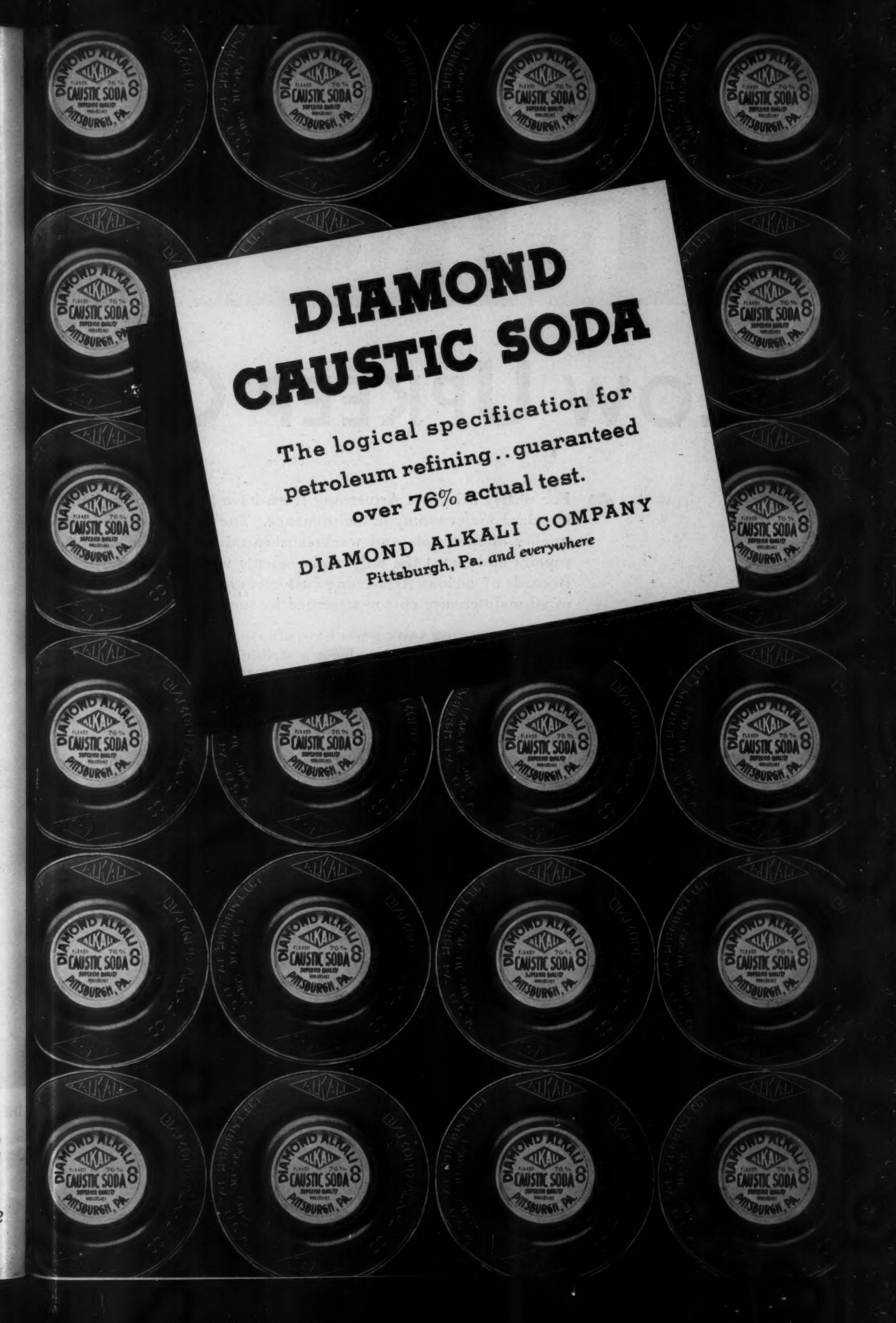
The photograph shows a 1000 kw. mixed flow condensing turbine utilizing steam from reciprocating units and exhausting to a condenser served by a cooling tower on the roof.

Our engineers will supply full information upon learning of your conditions and requirements.

8174

De Laval *Steam Turbine Co.*, Trenton, N.J.

Manufacturers of Steam Turbines, Centrifugal Pumps, Propeller Pumps, Rotary Displacement Pumps, Centrifugal Blowers and Compressors, Worm Gears, Helical Speed Reducing Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery. Sole Licensee of the Bauer-Wach Exhaust Turbine System.


DIAMOND
CAUSTIC SODA
The logical specification for
petroleum refining..guaranteed
over 76% actual test.
DIAMOND ALKALI COMPANY
Pittsburgh, Pa. and everywhere

PROOF

# of Low Upkeep Cost

For nearly 25 years Armstrong traps have been setting a high standard for economy in maintenance. The basic design and the quality of materials and workmanship minimized the need for repairs and about the only replacements were valves and seats. Records of various Armstrong customers show as much as 90% of all maintenance cost represented by such replacements.

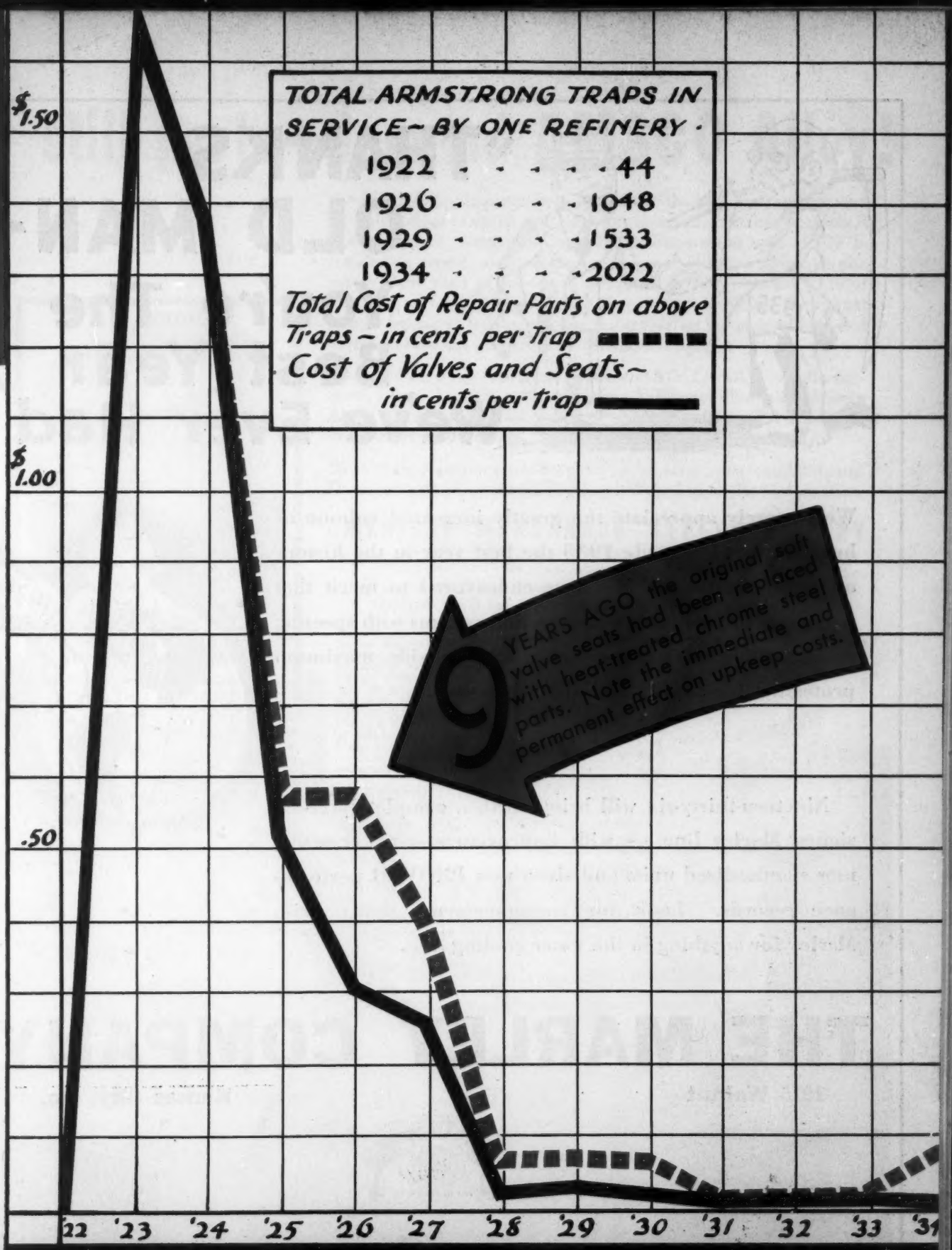
While Armstrong valve parts have always been made of the best available metal, there has been a striking improvement in this direction in the past decade. Phosphor bronze valves used to be considered good—and thousands of Armstrong traps so equipped gave fine records of trouble-free service. But under some conditions bronze would wear rapidly. Special alloys were better but not good enough for Armstrong. By constantly experimenting with heat treatment of chrome steel for the past 12 years, the present standard valve parts were developed. They have no fancy name but their uniform hardness and toughness makes them highly resistant to wear and corrosion. Their close approach to the ideal for long, hard service is best shown by facts and figures.

The chart on the opposite page represents the actual maintenance costs on Armstrong traps used by one typical large refinery. This is clear proof of the economy and dependability of Armstrong traps. We still offer our original 90-day free trial of as many Armstrong traps as you want to test.

ARMSTRONG MACHINE WORKS

852 Maple Street — Three Rivers, Michigan

ARMSTRONG
STEAM TRAPS


TOTAL ARMSTRONG TRAPS IN SERVICE – BY ONE REFINERY –
1922 - - - - - 44
1926 - - - - 1048
1929 - - - - 1533
1934 - - - - 2022
Total Cost of Repair Parts on above Traps – in cents per Trap
Cost of Valves and Seats – in cents per trap
$1.50
$1.00
.50
9 YEARS AGO the original soft valve seats had been replaced with heat-treated chrome steel parts. Note the immediate and permanent effect on upkeep costs.
'22 '23 '24 '25 '26 '27 '28 '29 '30 '31 '32 '33

The chart above is based on more than 16,500 trap years of service for a single user. The average cost of valves and seats per trap per year for the 13 year period is 15.2 cents and the average cost of all repair parts is 19.4 cents. But the real significance of this chart lies in the decreased costs after the change-over to heat treated valve parts had been made. The cost per trap per year (from 1928-1933 inclusive) dropped to 3.7 cents for valves and seats and to 4.8 cents for total repair parts. No wonder Armstrong users say you can install these traps and forget them

"THANKS OLD MAN- You're The Best Year We've Ever Had"

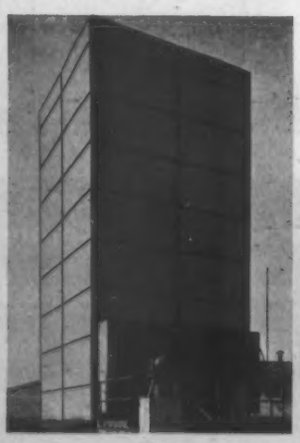
We sincerely appreciate the greatly increased volume of business that has made 1935 the best year in the history of our organization. We have endeavored to merit that patronage by designing water cooling systems with specific, demonstrable advantages that would provide maximum protection for any water cooling investment.

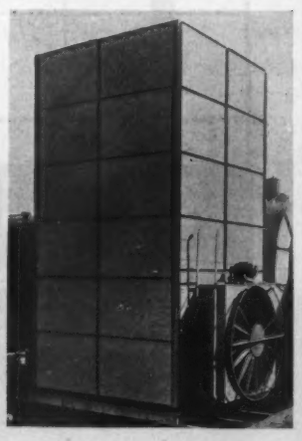
Nineteen-thirty-six will bring forth a completely re-designed Marley line — with improvements, refinements, new standardized units and sizes, new PROVED performance records. Look for announcements soon; write Marley for anything in the water cooling line.

THE MARLEY COMPANY

1915 Walnut **Kansas City, Mo.**

Let Us Spray
COOLING
MARLEY
EQUIPMENT
"THE BETTER WAY"



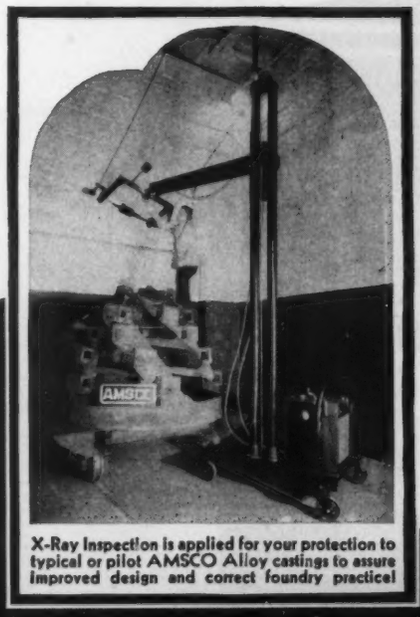


for still parts—demand AMSCO Alloy!

AMSCO Alloy is completely resistant to the high temperatures and corrosive gases to which still parts are subjected. Correctly applied, it does not crack, warp, bend or scale at temperatures up to 2100°F. Installation reports at hand are ample proof of these claims, — one shows eight years of service in cracking stills in operation 97% of the time, at temperatures ranging from 1400° to 1600° F. without sign of fatigue or failure — a true testimonial to the unusual heat and corrosion resistant properties of AMSCO Alloy.

Illustrated are a few typical still parts of AMSCO Alloy — tube supports, beams, hangers, and end plates. The larger illustration shows a partial shipment of tube plates of AMSCO Alloy F-10 from an order of 16,000 pounds.

Be sure—buy long time, trouble proof service when ordering oil still parts. *Demand castings of AMSCO Alloy!* Write for detailed information.



X-Ray Inspection is applied for your protection to typical or pilot AMSCO Alloy castings to assure improved design and correct foundry practice!

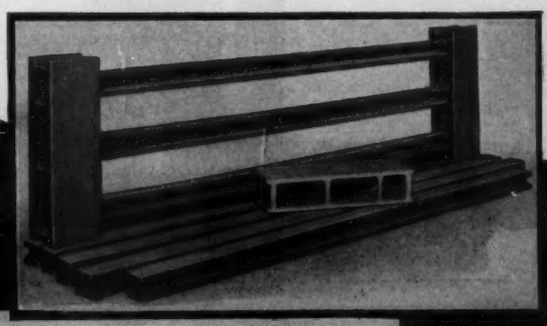
AMERICAN MANGANESE STEEL COMPANY

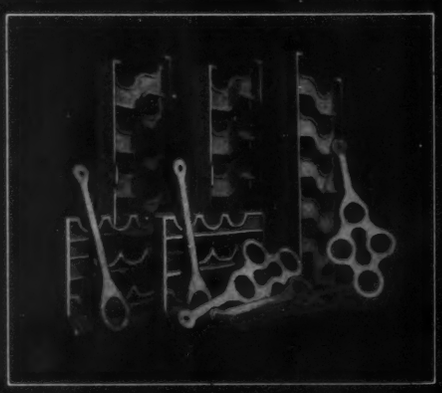
Division of American Brake Shoe & Foundry Company

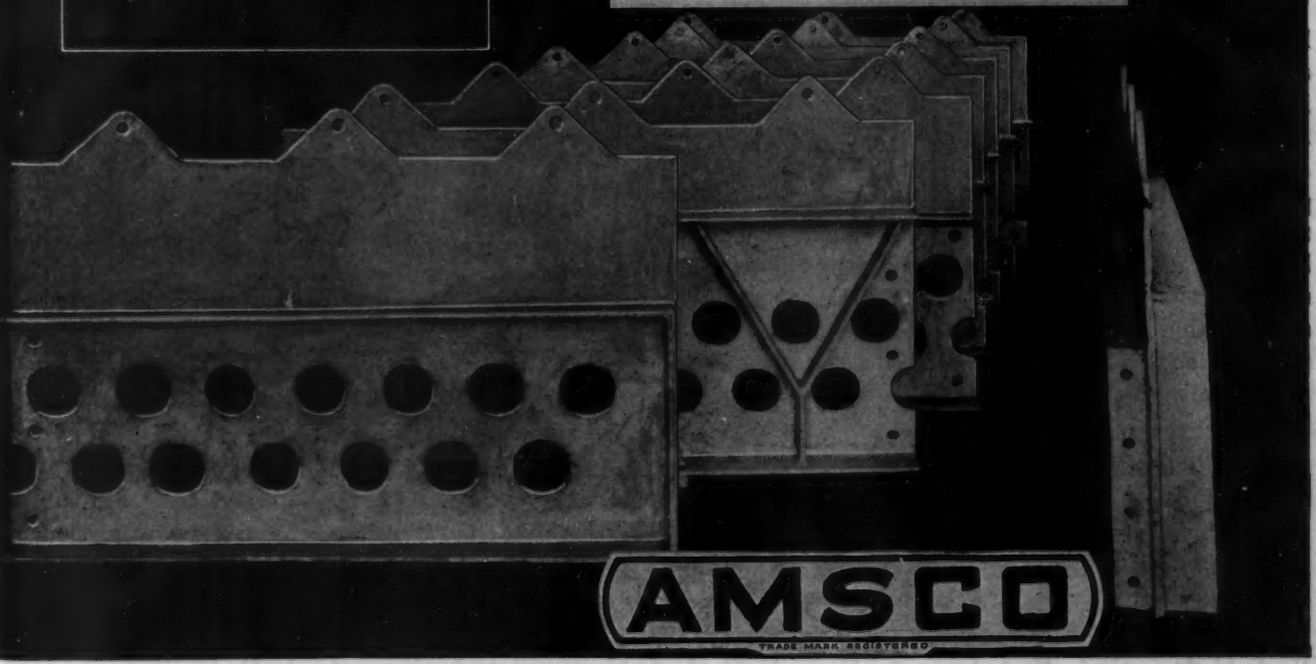
404 East 14th Street, Chicago Heights, Ill.

Foundries at Chicago Heights, Ill.; New Castle, Del., Denver, Colo.; Oakland, Calif.; Los Angeles, Calif.; • Offices in Principal Cities

Typical AMSCO Alloy heat and corrosion resistant castings for use in ordinary stills and cracking stills are shown herewith —hangers, beams, tube supports, end plates, etc., parts that are completely resistant to acid gases and high temperatures. AMSCO Alloy is your guarantee of longer service!



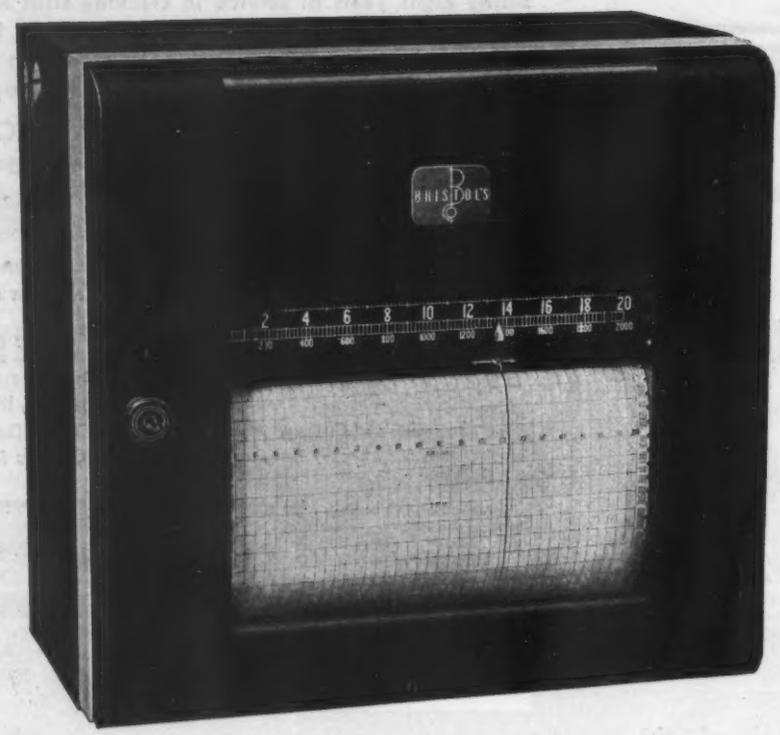




AMSCO

TRADE MARK REGISTERED

Industry Acclaims *this fine pyrometer*

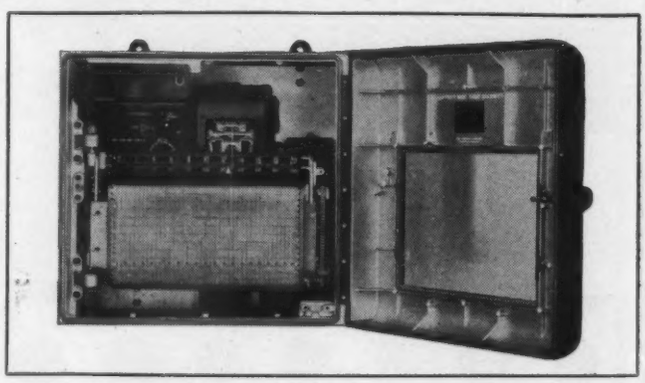


Built by the pioneer makers of Pyrometers, this latest Bristol's sets a new standard in potentiometer design and craftsmanship

Only a mere month or so has elapsed since this new Bristol's Wide-Strip Pyrometer was first announced at the Chicago National Metal Congress in October. Yet according to the ever-increasing number of enthusiastic reports that are coming in, it is the finest pyrometer ever presented to industry! Again Bristol design and craftsmanship have triumphed!

The use of a new principle in the balancing mechanism permits even the smallest deflections of the galvanometer to be measured and recorded. The pen responds promptly. Balance is quickly restored. Changing temperatures are speedily and accurately charted. Thanks to the elimination of back lash, lost motion, irregularities and the uncertainties unavoidable with friction wheels, ratchets and the like, this Bristol's sets a new standard in simplicity.

There are many features which merit careful appreciation. Besides the unusually wide strip chart, "far vision" indicating scale, heavy duty galvanometer, duplex slide wire, these are fully described in Catalog 1450 mailed on request. Write for a copy.



THE BRISTOL COMPANY · WATERBURY · CONNECTICUT

Branch Offices in Principal Cities. Canada: The Bristol Co. of Canada, Ltd., Toronto. England: Bristol's Instrument Co., Ltd., London, S.E. 14

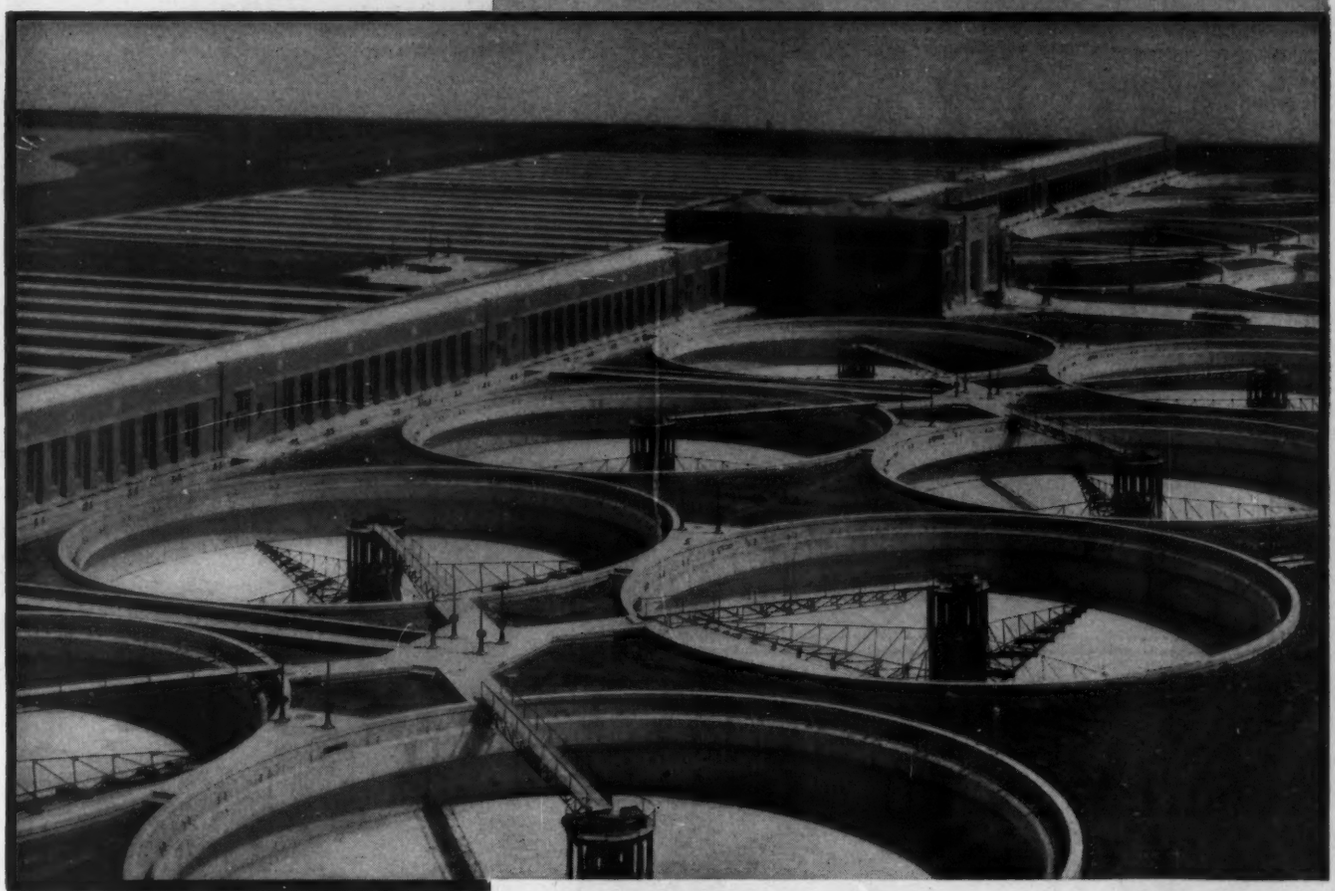
BRISTOL'S

TRADE MARK REG. U.S. PAT. OFF.

WIDE-STRIP POTENTIOMETER PYROMETER

$14,000,000 *protected against rust*

Entire steel structure of new Cleveland Sewage Plant painted with EAGLE Sublimed BLUE LEAD



A more enduring rust-inhibitive paint

• Here's why more and more engineers every year are recommending Eagle Sublimed Blue Lead as the most efficient rust-inhibitive paint for all metal surfaces:

1 Being pure lead, it is most enduring—gripping metal surfaces tenaciously. Does not chip or peel.

2 Being of extremely fine particles, it stays in suspension. Doesn't harden in container or clog the spraying nozzle. Equally satisfactory for brushing, spraying or dipping.

3 Chemically stops corrosion because of great basicity.

4 Brushes easily, flowing out like enamel. Painters like it.

5 Offers greatest economy. Lower in first cost than other high grade metal paints. Greater coverage—600 to 800 square feet per gallon. Saves 40 to 50% in material cost. Long lasting.

• You can buy Sublimed Blue Lead in paste form (pure lead ground in pure linseed oil) under the Eagle label—or in ready mixed form from reputable manufacturers. Send for descriptive booklet and free sample.

• New Easterly Sewage Disposal Plant, Cleveland, Ohio, recently completed at cost of $14,000,000. Metal surfaces were protected against rust and corrosion by Eagle Sublimed Blue Lead. Sludge bed steel equipment was also painted with Sublimed Blue Lead to guard it from strong acids of raw sewage—against which ordinary paint films cannot stand up.

EAGLE *Sublimed* BLUE LEAD

BASIC SULPHATE OF LEAD, BLUE

EAGLE RED LEAD
Rapid-drying qualities make it ideal for rush jobs

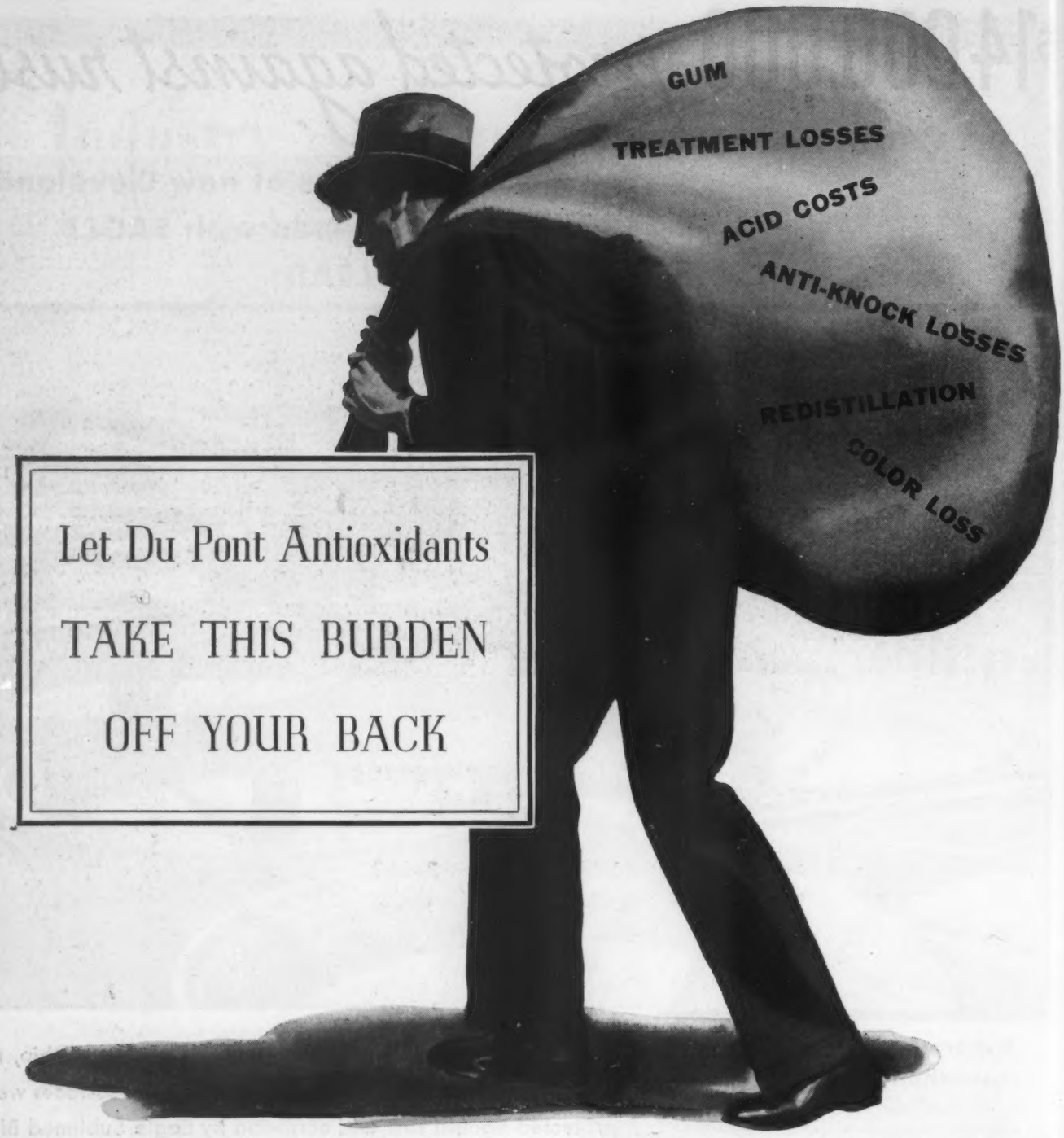
• MAIL COUPON FOR FREE SAMPLE

THE EAGLE-PICHER LEAD COMPANY, Dept. RN12 Cincinnati, Ohio.
Please send me free sample of Sublimed Blue Lead—also descriptive booklet on this more efficient rust-inhibitive paint.

Name_____

Address_____

City_____ State_____



AWAY with refining troubles! Antioxidants made by du Pont are the new, sensational step toward positive gasoline stabilization. They make it possible to stabilize high quality gasoline much cheaper than by the usual acid treatment and redistillation methods. And the anti-knock properties of the product are well preserved.

Du Pont Antioxidants prevent the formation of gum. Assure the highest possible yields of gasoline because acid treatment losses are minimized. Protect equipment from the ravages of sulfuric acid. Maintain color stability. And Du Pont Antioxidants are not expensive to use. The material cost of stabilization runs from ½¢ to 2½¢ per barrel. It is easy to see what this means. A better product at a lower cost.

Du Pont Antioxidants will put you one big jump ahead of your competitors. Consult one of our trained men for expert advice. Contact the Organic Chemicals Department, E. I. du Pont de Nemours & Co., Wilmington, Delaware.

DU PONT
REG. U. S. PAT. OFF.

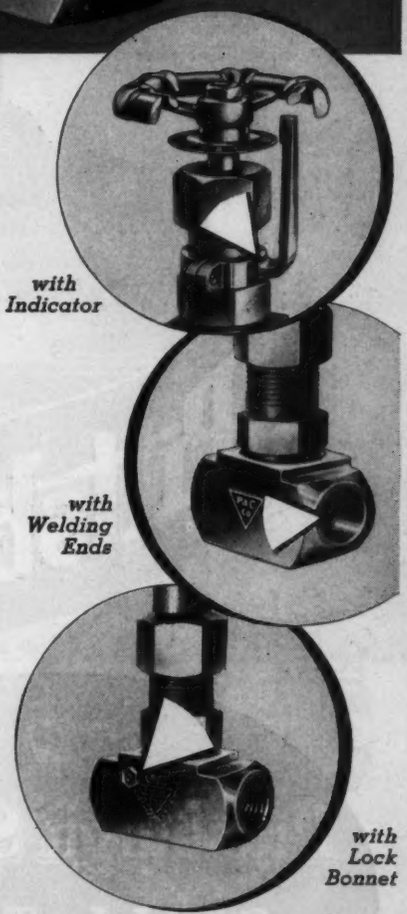
ANTIOXIDANTS

Bar Stock VALVES

FOR ALMOST ANY COMMERCIAL WORKING TEMPERATURE AND PRESSURE . . . FROM THE LOWEST TO THE HIGHEST . . .

● These neat, sturdy valves meet the strictest requirements of close control work in almost any commercial service. Furnished in bronze, carbon steel, 12% chromium stainless steel, 18-8% and in any combination of these metals. May be ordered with indicator, welding ends or lock bonnet as illustrated. Supplied also in the exclusive Pratt & Cady THRU-PORT design which permits cleaning out of heavy precipitates and deposits by running a rod through the line.

Let us tell you about the broad application possibilities of these versatile valves.



with Indicator

with Welding Ends

with Lock Bonnet

READING-PRATT & CADY COMPANY, INC.

In Business for Your Safety

An Associate Company of American Chain Company, Inc.

Bridgeport, Connecticut

READING-PRATT & CADY *Valves*

WHEREVER SEAMLESS SERVES

Wherever exacting service requirements and the assurance of safety necessitate the use of seamless steel pipe and tubing, Pittsburgh Seamless serves dependably and economically. It stands guard at vital points in many refineries against the hazards of pressure, temperature and corrosion . . . Available in regular carbon steel, and 4 per cent to 6 per cent chromium alloy steels of various types.

Pittsburgh Products

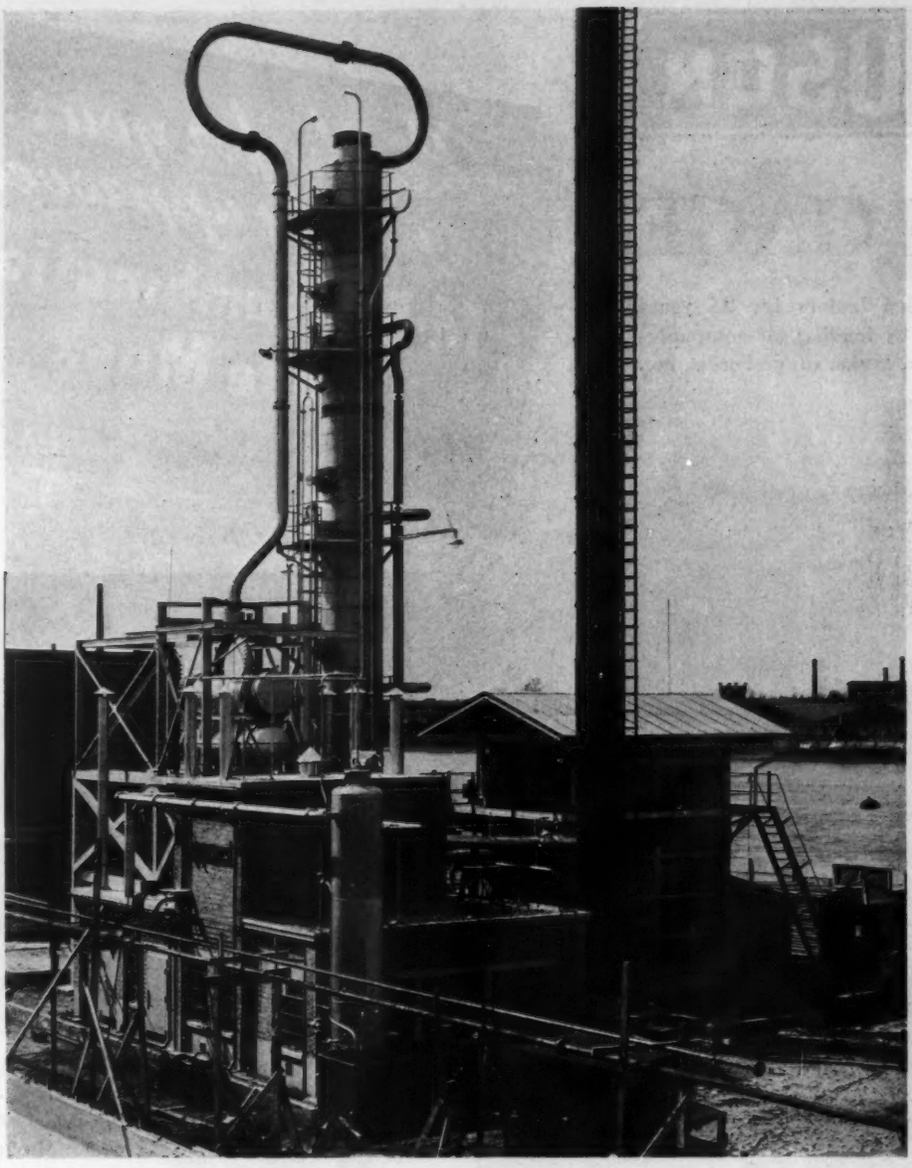
Pittsburgh Seamless

STILL TUBES
REFINERY
PIPING

PITTSBURGH STEEL COMPANY

PITTSBURGH • PENNSYLVANIA

New York Detroit Chicago
St. Louis Tulsa Houston
Los Angeles San Francisco



Fractionating Units

The general utility unit illustrated is a good example of ability to provide refinery apparatus to meet the specific conditions and market requirements of individual refiners. In this case the unit is of 3,500 barrels per day capacity, producing gasoline overhead, three side streams and fuel oil as residue. Provision for a stripper with cooler and piping, has been made in order that a lubricating oil side stream may be added in the future, if desired.

Weir control valves and internal stripping sections for side streams assure close control of products. Successful refineries in many countries form the background of engineering experience available for the study of your refinery problems, without obligation.

FOSTER WHEELER CORPORATION, 165 Broadway, New York, N. Y.

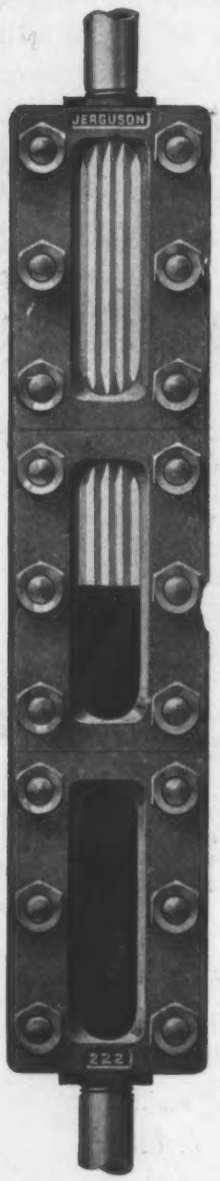
FOSTER WHEELER

JERGUSON

REFLEX GAGES

have been used for steam boilers for 25 years and are now being used by leading oil companies for indicating oil levels in tanks, towers, stills, etc.

The *empty* space appears WHITE



The *liquid* shows BLACK

They are safe and durable at the highest pressures and temperatures. We can furnish gages with or without valves for every type of service. Full information upon request.

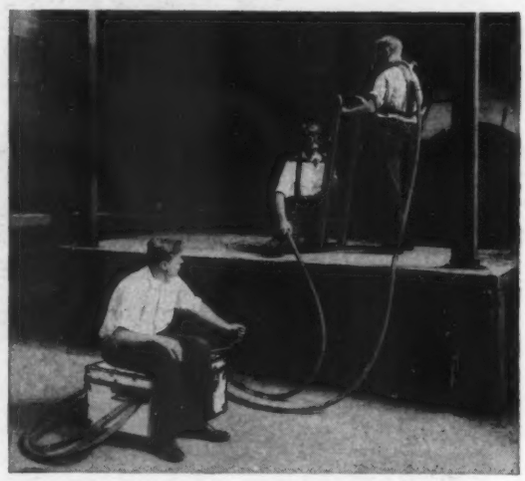
JERGUSON GAGE & VALVE CO.

87 FELLSWAY
SOMERVILLE, MASS.

Ready for you... a newly approved

M·S·A Combination Hose Mask

★



★

The *improved* M.S.A. Combination Hose Mask (the 2-man outfit is shown above) features a new, double-outlet blower of extra capacity, capable of amply supplying two workmen through as much as 150 ft. of hose to each mask. *It is officially approved by the U. S. Bureau of Mines.*

M.S.A. Hose Masks combine the utmost in protection, durability and wearing comfort,—that's why they're preferred everywhere. Five different types are available, hand or motor-operated or both, capable of supplying one to six workmen. Write for the new Hose Mask Bulletin, and let us demonstrate the unit that best fits your needs.

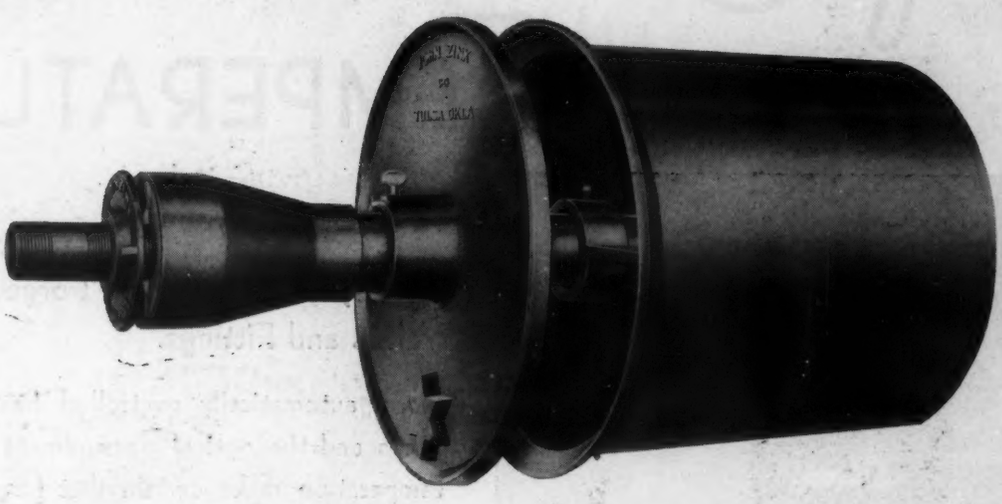
MINE SAFETY APPLIANCES CO.

BRADDOCK, THOMAS AND MEADE STREETS, PITTSBURGH, PA.

District Representatives in the Principal Cities

M. S. A. Products Include Breathing Apparatus . . . Inhalators . . . Masks of all types . . . Gas Indicators . . . Gas Detectors . . . M. S. A. Safety Goggles . . . M. S. A. Protective Hats and Caps . . . Edison Electric Cap Lamps . . . Safety Clothing . . . First Aid Equipment . . . Submarine Escape Apparatus . . . Descriptive Bulletins will be sent on request. . . .

JOHN ZINK BURNERS



MUST BE GOOD

Two of the major oil refining companies, during the last seven years, have ordered more than a thousand John Zink Burners for firing stills and boilers at their various plants.

These burners operate on either heavy fuel oil or refinery gases with short flame, and it is characteristic that practically all installations have been handled by the refinery engineers with results as anticipated.

JOHN ZINK BURNERS — **TULSA, OKLAHOMA**

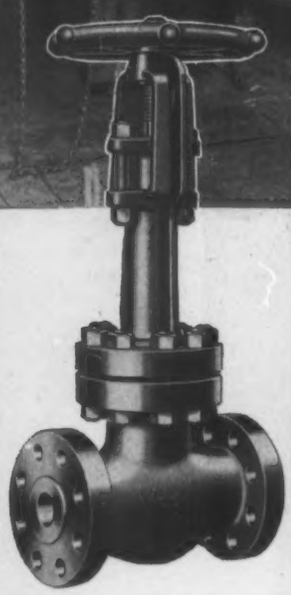
CONTROLLED FORGING TEMPERATURE

KNOW what you get!

Specify VOGT Drop Forged Steel Valves and Fittings.

Here, automatically controlled heating furnaces and the optical measurement of billet temperature make certain that forgings will be properly heated.

Such selection and control of temperature guards against any sacrifice of essential properties due to excessive heating.



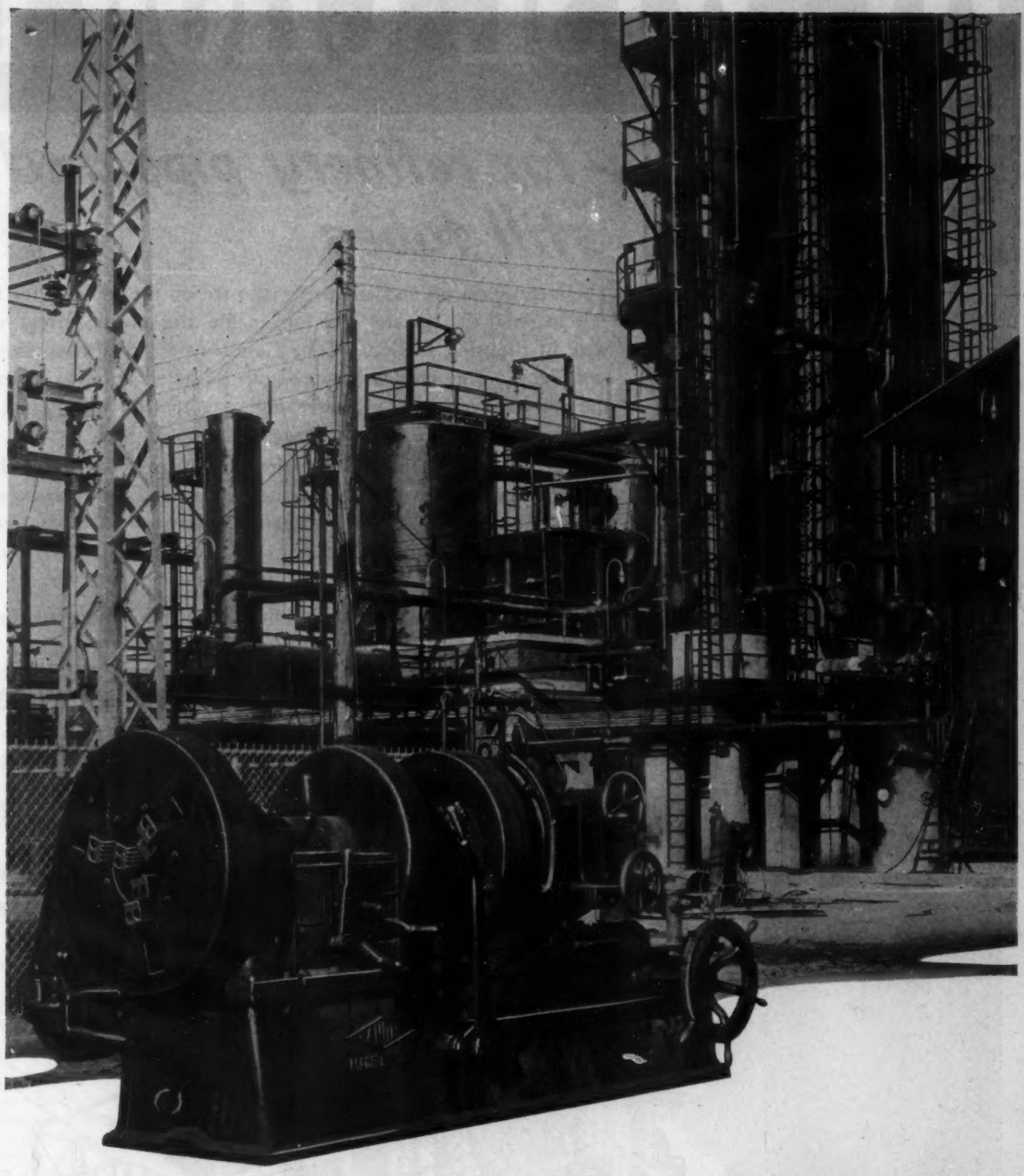
Manufacturers of: Drop Forged Steel Valves and Fittings, Ice Making and Refrigerating Machinery, Oil Refinery Equipment, Water Tube Boilers, Heat Exchangers.

Vogt DROP FORGED STEEL VALVES & FITTINGS

HENRY VOGT MACHINE COMPANY, Inc., LOUISVILLE, KENTUCKY

NEW YORK CHICAGO CLEVELAND PHILADELPHIA CINCINNATI KANSAS CITY DALLAS

For refinery piping . . .
You can't beat a LANDIS!



The LANDIS Pipe Threading and Cutting Machine is in a class by itself when it comes to the fabrication or maintenance of refinery piping.

A LANDIS is always powerful, sturdy, and fast in operation. Geared for high threading speeds, it will give maximum production.

The patented LANDIS tangential chaser, with its long life and wide range, insure low cost of upkeep and quick set-up changes.

A LANDIS is guaranteed to produce cleanly cut, well formed, accurately tapered threads.
Literature? Write today.

LANDIS MACHINE COMPANY, Inc.
Waynesboro, Penna

THE WISE CHOICE

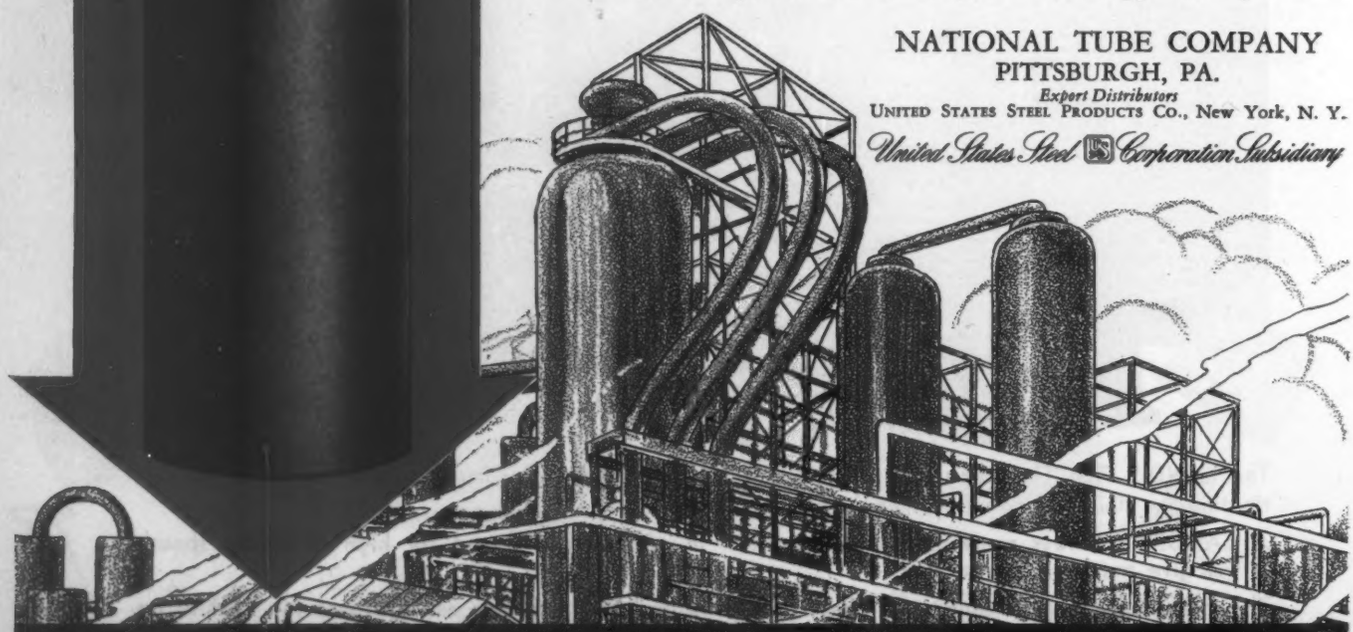
—for refinery pipe and still tubes

Refinery operators and engineers who are on the lookout for tubular material that would give longer life and greater safety will be wise in choosing National Tube Company 4%-6% Chromium Pipe and Tubes. This modern material can be relied upon to better meet the problems of higher pressures, higher temperatures and more severe corrosive conditions. Six advantages stand out in their favor:

1-High resistance to corrosion—2-Improved strength at high temperatures—3-Superior quality electric-furnace steel—4-Accurately controlled heat treatment—5-Unusual resistance to oxidation or scaling—6-Exceptional ductility for bending and forming.

Further, NATIONAL 4%-6% Chromium Pipe and Tubes are seamless—no welds; therefore they have uniform wall-strength throughout. Available in a wide range of diameters, wall-thicknesses, and lengths, and furnished with plain, upset, or otherwise formed ends when desired. Also, Sentry drilled (an exclusive feature) when so ordered. Consult NATIONAL engineers and metallurgists on your application problems.

NATIONAL TUBE COMPANY
PITTSBURGH, PA.
Export Distributors
UNITED STATES STEEL PRODUCTS CO., New York, N. Y.
United States Steel Corporation Subsidiary



NATIONAL TUBE COMPANY
4%-6% CHROMIUM
with molybdenum, titanium and other alloys

Chemical Engineers Meet at Columbus

THE twenty-eighth annual meeting of the American Institute of Chemical Engineers was held at Columbus, Ohio, November 13, 14 and 15. Technical papers were read covering subjects under the two classifications: applied chemical engineering and principles of chemical engineering. Plant trips, of which there were three each day, afforded an opportunity to visit many of the industries in that district, including oil refining, glass and paper manufacture and many others. Open house at Battelle Memorial Institute and Ohio State University offered an opportunity for the group to inspect these institutions.

New officers elected were: President, Martin H. Ittner; vice president, Fred C. Zeisberg; treasurer, Charles R. De Long; secretary, Frederic J. Le Maistre (re-elected); directors, Edward Bartow, James G. Vail, Gustav Egloff and Albert B. Newman.

The 1936 spring meeting of the American Institute of Chemical Engineers is to be a joint affair with The Institution of Chemical Engineers in London, England. Arrangements for this joint meeting include attendance at the World Chemical Engineering Conference and possibly at the meeting of the Society of Chemical Industry at Liverpool. The party anticipates sailing from New York approximately June 12, 1936.

During the year just completed the institute elected 90 active, four associate and 113 junior members. One new professional section, Maryland Section, with headquarters in Baltimore, was added. The University of Louisville (Kentucky) was added to the list of institutions accredited by the institute. During the year two new student chapters were admitted.

Work of A. S. T. M. Committee on Petroleum

COMMITTEE D-2 on Petroleum Products and Lubricants — Two new subcommittees are being organized, one on plant spray oils which will standardize various tests for these products, and the second on illuminating oils, to which has been assigned the task of modifying the present burning test methods for illuminating oils to overcome the difficulties now being encountered in obtaining apparatus conforming to the present specifications.

The subcommittee on corrosion test for lubricating oils has developed a cooperative test program using a testing machine in which oil is held at a predetermined temperature and pumped in small streams on bearings of various compositions. An attempt will be made to find test conditions which will yield results that may be correlated with performance in service in automobile engines.

The subcommittee on grease plans to develop a method for the determination of the dropping point of grease. Based on cooperative tests, it has been decided to submit the method using a spiral of copper wire, to the committee members for criticism. Consideration is also being given to a modification of the present penetration method for soft greases.

In connection with work on turbine oils, the committee plans to collect information from operating companies on tests employed to evaluate and differentiate turbine oils and to correlate the information so obtained. The significance of the carbon residue test for fuel oils is being studied and particular attention will be paid to the carbon residue of the 10 percent residue by distillation.

Other projects under way in the committee involve the preparation of a general specification for gasoline with suitable variations for climatic conditions; consideration of possible modifications of the tentative specifications for fuel oil; and the development of specifications for diesel fuels from the classification that has already been printed.

Two new sections of the subcommittee on motor oils are being organized; one on extreme-pressure lubricants and one on oiliness of motor oils.

The Look Box

(*Continued from page 554*)

Symposium on Heat Transmission

THE symposium on heat transmission to be held at Yale University, December 30 and 31, under the auspices of the Chemical Engineering Department, continues the policy, in augurated last December by the Division of Industrial and Engineering Chemistry of the American Chemical Society, of holding special meetings for chemical engineering symposia. The previous meeting, held at the Massachusetts Institute of Technology, December, 1934, features a symposium on distillation. The outstanding success of this meeting, as evidenced by the enthusiasm of those who attended, encouraged the division to continue the plan.

The last symposium on heat transmission held by the American Chemical Society was at the Washington meeting in 1924 under the chairmanship of W. H. McAdams. The committee in charge of the forthcoming meeting has selected the subject because of its wide appeal, not only to all chemical engineers but also to many industrial chemists and to engineers in other fields. In arranging the program the committee has attempted to attract all those whose interests lie in the broad field of heat transfer, including heat conduction in solids, heat transfer by convection between fluids, and solids and heat transfer by radiation.

The following program is announced:

Albert B. Newman—Heating and Cooling Rectangular and Cylindrical Solids.

W. J. Wohlenberg—The Energy Reaction at Points in a Furnace Cavity for Steady State Firing.

W. L. Badger and Nathan Fragen—Correlation of Heat Transfer Coefficients in Forced Circulation.

E. F. Holser—Heat Transmission With High Boiling-Point Organic Compounds.

Lawrence Washington and Max Marks—Heat Transfer and Pressure Drop in Rectangular Air Passages.

R. H. Heilman—Heat Insulation in Air-Conditioning Systems.

F. W. Adams—Heat Transmission Coefficients of a Film-Type Horizontal Pipe Cooler.

F. H. Rhodes—Rates of Heat Transfer in the Condensation of Mixed Vapors.

R. A. Bowman—Mean Temperature Difference Corrections in Multi-Pass Heat Exchange.

W. H. McAdams—To be announced later.

E. N. Seider—A Study of Factors Affecting Heat Transfer of Fluids in Viscous Flow Inside Pipes.

G. H. Montillon—Heat Transfer in Tubes at Various Inclinations.

A. D. Moore—A Demonstration of the Hydrocal. (A new hydrodynamic calculating instrument for solving heat transfer and temperature rise problems in the transient state.)

Meetings will be held at the Sterling Chemistry Laboratory on Monday afternoon, December 30, and on Tuesday morning and afternoon, December 31. A brief address of welcome will be given by Robert E. Doherty, dean of the Yale Engineering School. On Monday evening there will be an informal dinner followed by an address by a prominent scientist or engineer. Igor Sikorsky, president of Sikorsky Aircraft, and internationally known airplane designer, has tentatively accepted the invitation to give this talk.

Conventions

S. A. E. Society of Automotive Engineers, annual meeting, Book-Cadillac Hotel, Detroit, Michigan, January 13 to 17.

A. S. T. M. American Society for Testing Materials, regional meeting, Wm. Penn Hotel, Pittsburgh, Pennsylvania, March 4.

A. C. S. American Chemical Society, Petroleum Division, Symposium on Motor Fuels, Kansas City, Missouri, April 13 to 17.

N. P. A. National Petroleum Association, semi-annual meeting, Cleveland Hotel, Cleveland, Ohio, April 16 to 18.

N. G. A. Natural Gasoline Association of America, Mayo Hotel, Tulsa, Oklahoma, May 13 to 15.

Exposition. International Petroleum Exposition and Congress, Tulsa, Oklahoma, May 16 to 23.

A. P. I. American Petroleum Institute, mid-year meeting, Tulsa, Oklahoma. Schedule to be held in May.

C. N. G. A. California Natural Gasoline Association holds monthly meetings at designated places.

Book of A. S. T. M. Tentative Standards

THIS annual publication of the American Society for Testing Materials is the only volume containing all of the A. S. T. M. tentative specifications, methods of test and definitions of terms covering engineering materials and the allied testing field. These tentative standards embodying the latest thoughts and practices, are widely used throughout industry.

The 1935 edition of the book (1500 pages) contains 290 tentative stand-

ards. Of these 75 are included for the first time, while some 65 were revised this year and are given in their latest approved form. A general classification of the items, with the number in each group, follows:

Ferrous metals (forgings, castings, pipe, etc.) 48
Non-ferrous metals 32
Cementitious, ceramic, concrete and masonry materials 54
Paints, varnishes, lacquers and paint materials; waterproofing and roofing materials 27
Petroleum products and lubricants..17
Road materials 41
Rubber products; textile materials; electrical insulating materials.....49
Miscellaneous materials and general methods 22

New tentative specifications published for the first time in 1935 cover the following ferrous and non-ferrous materials: Seamless steel still tubes for refinery service, seamless steel heat-exchanger and condenser tubes, steel pipe flanges for general service, heat-treated carbon steel and alloy steel track bolts, carbon steel and alloy steel castings for railroads, steel castings for miscellaneous uses, uncoated and zinc-coated wrought iron sheets, electrodeposited coatings on steel, several types of chromium and chromium-nickel steel castings and sheets, lead-coated sheet copper, lead and tin-base alloy die castings, phosphor-bronze plates for bridges and structures. Three new methods of spectrochemical analysis of various non-ferrous metals are given also.

In the non-metallic materials fields new specifications cover concrete irrigation pipe, soils (several methods of testing), basic sulfate blue-lead, shellac (testing), hiding power of white pigments, pile floor covering, wool (fineness test). Other products covered by new tentative standards are coal (grindability tests and screen analysis), vulcanized rubber (physical and adhesion tests), rayon woven fabrics, cotton fibers.

Extensive revisions have been made in 1935 in the requirements for carbon-steel plates for boilers and other pressure vessels, cold-rolled strip steel, high-tensile strength plates, alloy-steel castings for service at 750 to 1100 degrees Fahrenheit, timber piles, building brick, concentric lay copper cable, bronze trolley wire, and other materials.

In addition to the 290 A. S. T. M. tentative standards, the 1935 Book of Tentative Standards includes all proposed revisions of standards, which are published to elicit criticism before final adoption. Changes in some 35 standards have been proposed.

To facilitate the use of the book a complete subject index has been included, listing items under the materials and subjects to which they apply; and two tables of contents are given, one listing the standards in the order they appear (grouped under general subjects) and the second listing the items in numeric sequence of serial designation.

Copies in cloth binding at $8.00 each, or in heavy paper cover, $7.00, can be obtained from A. S. T. M. headquarters, 260 South Broad Street, Philadelphia.

Perkin Medal to Warren K. Lewis

THE Perkin Medal Committee has unanimously elected Warren K. Lewis of the Massachusetts Institute of Technology to receive the Perkin medal for 1936. This medal is awarded annually by the Society of Chemical Industry to a medalist elected by a committee representing the five chemical societies in the United States. The award is made for valuable work in applied chemistry.

The medal will be presented on January 10, 1936, at a meeting to be held at the Chemist's Club, New York City. The subject of Professor Lewis' paper will be "Application of Physical Data to High-Pressure Processes." Dr. Lewis and his important work is well known in petroleum refining circles.

Suggestions on Symbols and Abbreviations Asked

THE difficult task of preparing standard letter symbols and abbreviations for scientific and engineering terms is now being undertaken by a committee which is being organized under the procedure of the American Standards Association. Standards already approved will be studied by the committee, and many may be revised.

Because of the difficulty involved in writing this universal simplified language for all phases of engineering, the committee is urging those interested to send comments on the standards which have already been approved and suggestions for useful new symbols and abbreviations which are not now included to Dr. J. Franklin Meyer, National Bureau of Standards, Washington, D. C., chairman of the committee.

Twelve standards for letter symbols, abbreviations, and graphical symbols have been developed by the technical committee of the American Standards Association which has been at work for many years. Recently, in order to simplify the work of the committee, it was divided into two parts, one covering the letter symbols and abbreviations, and the second covering the graphical symbols.

The committee working on letter symbols and abbreviations, which is now beginning its work, has 12 subcommittees covering the following broad subjects:

Symbols and Signs for Mathematics.
Symbols for Physics and Mechanics.
Symbols for Structural Analysis.
Symbols for Hydraulics.
Symbols for Heat and Thermodynamics.
Symbols for Photometry and Illumination.
Symbols for Aeronautics.
Symbols for Electric and Magnetic Quantities.
Symbols for Radio.
Abbreviations for Scientific and Engineering Terms.
Astronomy and Surveying.
Geodosy.

The committee which will prepare standards on graphical symbols will start work soon and will also request

20 TROY-ENGBERG STEAM ENGINES

sold in the last two months for driving oil pumps in refineries

Latest Troy-Engberg Vertical Steam Engine, Type E, showing modern variable eccentric which cuts steam consumption by 15%. Sizes up to 450 H.P.

TWO IMPORTANT PARTIES besides ourselves were involved in these transactions—the refinery officials who specified the drive and the manufacturers of the pumps who assembled the units.

Inherent in the modern steam engine are certain characteristics which make them mechanically and economically better for most pump drives and for many of the other drive requirements. They have high-starting torque; can go into action quickly; are smooth and responsive to automatic control; are highly flexible; involve little maintenance; and eliminate fire hazards.

If you are buying pumps or any other equipment requiring a drive, look fully into the merits of Troy-Engberg Steam Engines. Look into their By-Product Power value.

TROY ENGINE & MACHINE CO.
937 Railroad Ave. Troy, Pa.

TROY-ENGBERG
HORIZONTAL AND VERTICAL STEAM ENGINES • A C & D C GENERATING SETS

comments and suggestions on its phase of the problem.

The standards already approved by the American Standards Association in this field and which are being studied by the committee for possible revision are:

Symbols for Mechanics, Structural Engineering, and Testing Materials (Z10a-1932).

Symbols for Hydraulics (Z10b-1929).

Symbols for Heat and Thermodynamics (Z10c-1931).

Symbols for Photometry and Illumination (Z10d-1930).

Aeronautical Symbols (Z10e-1930).

Mathematical Symbols (Z10f-1928).

Letter Symbols for Electrical Quantities (Z10g1-1929).

Graphical Symbols Used for Electric Power and Wiring (Z10g2-1933).

Graphical Symbols Used in Radio (Z10g3-1933).

Graphical Symbols Used for Electric Traction Including Railway Signaling (Z10g5-1933).

Graphical Symbols for Telephone and Telegraph Use (Z10g6-1929).

Abbreviations for Scientific and Engineering Terms (Z10i-1932).

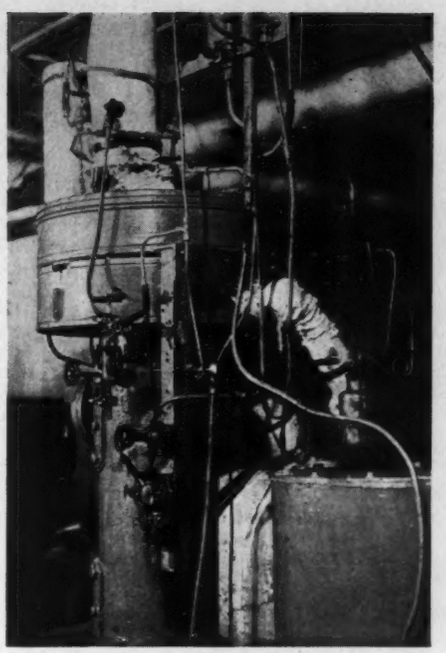
Copies may be obtained from the American Standards Association office, 29 West Thirty-ninth Street, New York, at prices ranging from 20 cents to 40 cents.

Podbielniak Centrifugal Super-Fractionator Shown

LAST month at the fifteenth Exposition of Chemical Industries, New York, the Podbielniak Laboratories of Chicago displayed publicly for the first time an operating demonstration unit of the Podbielniak Centrifugal Counter-Current Super-Contactor as applied to exceedingly precise fractional distillation, together with accessory exhibits explaining the theory, applications and performance of this type of apparatus. The principle and general theory of the centrifugal super-contactor, as first announced by Dr. Walter J. Podbielniak at the April meeting of the American Chemical Society this year at New York, are absolutely new in technology and have been applied to the design and construction of distillation, gas absorption, and solvent extraction units of both small and large capacities and of great efficiencies surpassing those possible with conventional equipment, but compact enough to be housed in ordinary rooms, and of low first and operating costs.

The term "Centrifugal Counter-Current Super-Contactor" is said to be purposely very broad and includes not only distillation and gas scrubbing but also any extended counter-current contact between a liquid and a gas phase or between two or more immiscible liquid phases. Solvent extraction, evaporation of water in a stream of air, chemical reactions, etc., are included in its meaning.

Practically all equipment developed or used to date, falling under the classification of "counter-current contacting" depends on the difference in density of the two phases (or graups of phases) and on the force of gravity to bring about the desired counter-current motion of these phases relative



Podbielniak Centrifugal Super-Fractionator. (Vapor capacity 100 lb. per hour)

to each other. There are a few special mechanical agitation types of equipment where rotating discs or other moving elements assist in securing intimacy of contacts. However, in these also gravity is absolutely depended upon for the functioning of the equipment. In the Podbielniak Centrifugal Counter-Current Super-Contactor, controlled centrifugal force is substituted for gravitational force to do the functions of a bubble tray distilling tower, of a gas absorber, multiple tank solvent extractor, etc. The substitution is so radical and complete that the new type units can be made to function satisfactorily upside down, or in any other orientation, or even with changing orientation. The fluid passage can be compactly coiled into a spiral or otherwise arranged to combine great length (even up to several hundred feet) with great compactness of overall dimensions. The use of high centrifugal force permits vapor velocities up to 100 feet per second or more, liquid velocities up to 10 feet per second or more, and therefore great capacities per unit cross-sectional area of passage and for the apparatus dimensions. Nevertheless, the pressure drop through the apparatus can be made as small as desired, or even made negative. The intimacy of contacting is very great and columns equivalent to several hundred plates may be easily constructed, especially when the rotors are "multi-staged" one above the other. The pitch and width of the spiral, the clearance, the length of the passage, and the speed of rotation can all be varied to meet any requirements for capacity, turbulence, time of contact, and intimacy of reaction.

Figure 1 is a photograph of a 100-pound-per-hour vapor capacity centrifugal precise fractionating unit. This unit is equipped for atmospheric, pressure and vacuum distillation, and is equivalent in performance to a packed or bubble tray tower more than 60 feet high, although barely five feet high overall.

Units of this type are available for ordinary as well as extremely high precision fractionations of all types of distillable products, such as petroleum hydrocarbons, organic chemicals, and even for the commercial production of concentrated heavy water from ordinary water; also for both analytical and large scale solvent extractions and certain types of chemical reactions.

The most interesting immediate applications are the commercial concentration of heavy water from ordinary water, the ultra-fractionation of alcoholic liquid, essential oils, perfume components, etc., into their pure compounds, the multi-stage solvent extraction of lubricating oils, vacuum distillation of lubricating oils, fatty acids, and other high-boiling easily decomposable products, the treatment of highly corrosive products requiring stainless steel, monel or other corrosion-resistant metals, and, for the first time possible, the true counter-current process of chemical reaction, where this is desirable. Wall charts, and other exhibits were shown to show the scope of applications possible with the new apparatus.

Fuel Oil Demand Increases in 1934

THE domestic demand for gas oil and fuel oil in 1934 gained about 22,000,000 barrels over the deliveries in 1933; but the total is still 54,000,000 barrels less than the peak demand in 1929, according to reports submitted to the Bureau of Mines by petroleum refiners and marketers for 1934 and estimates based on data from reliable sources for 1932 and 1933.

Railroads, gas and electric power plants, smelters and mines, manufacturing industries, heating oils, oil company consumption and miscellaneous uses showed gains over 1933. Exports including shipments to non-contiguous territories also increased noticeably in 1934, totaling 28,605,000 barrels, compared with 20,563,000 barrels in 1933 and 19,994,000 barrels in 1932.

Fuel oil purchases by the railroads in 1934 were nearly 9 percent more than the 1933 demand but were still below the totals reported for the years 1926 through 1931. The loadings of bunker oil for vessels engaged in foreign and coastwise trade have declined steadily since 1930 but the rate of decrease was not so great in 1934, the loss being only about a million barrels, compared with a two million-barrel loss in 1933.

Fuel oil deliveries to gas and electric power plants showed a gain in 1933 and 1934 over 1932, but the increase is not outstanding. The fuel oil requirements of smelters and mines also showed an upward trend in the past two years, the total in 1934 being about 37.5 percent over 1932 and 7 percent over 1933.

Manufacturing industries, including "iron and steel products," "chemicals and allied industries," "automotive industries," "textiles and their products," "paper and wood pulp," logging and lumbering," "cement and lime plants," "ceramic industries," "food industries," and "other manufacturing" appearing in

the 1931 report, required 52,128,000 barrels of fuel oil in 1934, a gain over the three previous years and approaching the 1930 total of 53,921,000 barrels.

Some oil companies in reporting their sales of heating oils to the Bureau of Mines found it impossible to separate commercial and domestic grades. For this reason all heating oils from No. 1 to the heavy commercial heating grades are included in the 1934 total and comparable totals have been compiled for the years 1930-1933. These revised figures indicate a steady increase in demand for heating oils except for 1931, when a decline was registered. The increase in the market for heating oils in 1934 was outstanding, the gain being over 20 percent compared with 1933.

Range oil, which is usually a partly refined kerosene used chiefly in the New England area for cooking, space heating and water heating, showed more than a 50 percent gain in demand in 1934 compared with 1933. Sales of range oil, which are not included in the fuel oil totals, were reported as 15,756,000 barrels in 1934, compared with 10,269,000 barrels in 1933 and 6,841,000 barrels in 1932.

Oil companies in their field and refinery operations used about 1,200,000 barrels more of fuel oil in 1934 than in 1933. As oil used as fuel at refineries dropped slightly in 1934 compared with 1933, the increased use by oil companies is the result of more extensive field operations.

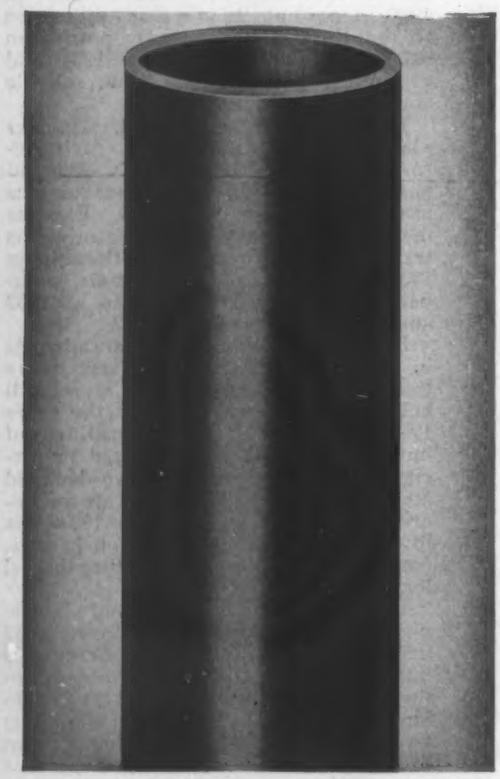
Natural Gas Industry Has Material Recovery in 1934

THE marketed production of natural gas, which had been adversely influenced by the depression in 1931, 1932 and 1933, registered a notable recovery in 1934, when the total output was 14 percent above the level of 1933, according to the United States Bureau of Mines, Department of the Interior. The total output in 1934 was 1,770,721,000,000 cubic feet, compared with 1,555,474,000,000 cubic feet in 1933 and with 1,943,421,000,000 cubic feet in the peak year of 1930. Although the distribution of natural gas for domestic purposes increased slightly, the major portion of the recovery in total distribution in 1934 was due to a material gain in demand for industrial purposes.

The downward trend in the value of natural gas at the wells, which began in 1929, was continued in 1934, when the producers received an average of 6.0 cents per thousand cubic feet, compared with an average of 6.2 cents in 1933. As in most recent years, the decrease in the average well value conformed to the decline in Texas, the leading producing state. If it were not for the consumption of large quantities of 2-cent gas in Texas for field purposes and in carbon-black manufacture, the national average would be considerably above 6 cents; in fact, the producers in some states receive more than 20 cents per thousand. Although the average price paid by domestic and commercial consumers increased slightly in 1934, the decline in the average industrial price was sufficient to cause the average value of the entire production at points of consumption to decline from 23.7 cents per thousand cubic feet in 1933 to 22.3 cents in 1934.

The total consumption of natural gas, or production (1,770,721,000,000 cubic feet) plus imports from Canada (68,000,000 cubic feet) minus exports to Canada and Mexico (5,801,000,000 cubic feet), amounted to 1,764,988,000,000 cubic feet. Of this total, 554,542,000,000 cubic feet (31 percent) was used for field purposes; 288,236,000,000 cubic feet (16 percent) was used by domestic consumers; 91,261,000,000 cubic feet (5 percent) by commercial consumers; 229,933,000,000 cubic feet (13 percent) was consumed in carbon-black manufacture; 127,896,000,000 cubic feet (7 percent) was consumed at electric public-utility power plants; 79,965,000,000 cubic feet (5 percent) at petroleum refineries, and 27,331,000,000 cubic feet (2 percent) at cement plants, leaving 365,824,000,000 cubic feet (21 percent) consumed for "other" industrial purposes. Compared with 1933, these data indicate chiefly gains in the ratios for carbon-black and refinery consumption, balanced by a decrease in the ratio for domestic consumption.

The number of domestic and commercial consumers of natural gas in 1934 was 7,566,000, compared with 7,232,000 for the previous year. Included in the 1934 figure are 2,147,000



ADVANTAGES

Seamless—no welds.
High tensile strength.
Exceptional uniformity.
Unusual ductility.
Resistant to corrosive influences.
Made from Superior quality open hearth steel.
Complete range of sizes, wall-thicknesses, and lengths.
Readily adaptable to any type of joint.
Proved performance under exacting service.
A product of the largest manufacturer of Seamless Pipe.
Sentry drilled (when ordered) an exclusive feature.

THE WISE CHOICE
for
STILL TUBES

National Still Tubes are solving the problems of refinery engineers where high pressures, high temperatures, and severe corrosive conditions are involved. Refinery engineers are turning more and more to National 4%—6% Chromium Pipe and Tubes for still tubes and also for furnace tubing, hot oil lines, tubular parts of heat exchangers, condenser tubing, return bends, etc. They know that RELIABILITY counts most in Refinery Piping. They rely on National Seamless for "Safety First."

Some of the leading advantages of National Seamless Pipe and Tubes are listed below, for your interest.

We represent National Tube Company in the Gulf Coast territory, and carry in stock a complete line of National Seamless tubular products for refinery and natural gasoline plant service.

MAINTENANCE ENGINEERING CORPORATION

1400 Conti P-6338 LD-409

HOUSTON, TEXAS

consumers of mixed gas, compared with 2,038,000 in 1933.

The number of gas wells completed increased from 932 in 1933 to 1373 in 1934, but the number of producing gas wells declined from 53,660 on December 31, 1933, to 53,260 on December 31, 1934.

The number of employes in the natural gas industry, as reported by the distributors, increased from 48,500 on December 31, 1933, to 52,300 on December 31, 1934.

The total interstate and export movement of natural gas rose from 346,810,400,000 cubic feet in 1933 to 414,183,000,000 cubic feet in 1934, an increase of 19 percent.

Bureau Makes New Gasoline Survey

DURING the winter of 1935-1936 the Bureau of Mines will make a comprehensive survey of commercial motor fuels sold throughout the United States, thus resuming the work of this nature which was dropped in 1933. R. A. Cattell, chief engineer of the petroleum division, will be in charge of the survey. Dr. T. G. Delbridge, the Atlantic Refining Company, has been active in working out the new plan of operation and accumulation of data, which involved the confidential use of individual company survey data of similar nature, rather than actual testing of hundreds of samples by the bureau itself. With the proper cooperation on the part of all of the large oil companies who make such annual surveys the work of the present survey should be facilitated and delivery of this important information to the industry expedited.

Evaporation of Gasoline Causes Large Losses

EVAPORATION of gasoline from bulk-storage stations is one of the major sources of loss in the marketing of gasoline, according to a report just issued by the U. S. Bureau of Mines, Department of the Interior, in which it is estimated that over 5½ million barrels of gasoline, or 1.5 percent of the domestic demand during 1933, were lost through evaporation of the more volatile constituents. The elusive features of this very deceptive source of loss are due to the relatively large coefficient of expansion of gasoline. Frequently the variation of atmospheric temperature causes a change of several percent in the volume of gasoline in a storage tank within a comparatively short time.

The oil industry is concerned greatly in the prevention of evaporation losses in all its phases. During the last several years, many inquiries have been made of the Bureau of Mines with special reference to measures for reducing evaporation losses from bulk-station plants. In its study of that subject, the Bureau has made evaporation tests of several typical bulk stations to determine the evaporation losses under different operating conditions and with equipment of different degrees of tightness and general upkeep. The reported results of these tests deal principally with the reduction of evaporation losses of gasoline from bulk-storage stations equipped with tanks having capacities of 10,000 and 12,000 gallons. The design and construction of bulk stations and the products handled through them vary greatly. Accordingly, the report describes in detail the gasoline and the station equipment at the plants where the investigations were made in such a way that the individual operator will be able to select the test conditions that correspond most nearly to those at his own plant.

Gasoline bulk-storage stations are the supply depots of the communities they serve and therefore must have enough storage capacity to meet the demand for motor fuel for periods ranging from a few days to several weeks, depending upon their location with reference to the source of supply. Bulk stations usually have storage facilities ranging from 15,000 to more than 2,000,000 gallons, although some stations cannot take more than a 6000-gallon tank car of gasoline at any one time. The average bulk station throughout the mid-central portion of the United States has storage facilities for about 36,000 or 40,000 gallons of gasoline. The individual storage tanks in these stations usually have a capacity of about 10,000 or 12,000 gallons each, although some of the larger plants have tanks with capacities of 420,000 gallons (10,000 barrels) or more each. These larger-capacity tanks are of the vertical type. In the smaller stations, equipped with tanks having capacities of 10,000 or 12,000 gallons

The 12 issues of The REFINER which are to be published in 1936 will be a valuable

REFERENCE BOOK

for every man in the refining industry.

These issues will contain the latest information on refinery methods, processes and practices.

Be sure of receiving volume fifteen of The REFINER in its entirety. Send in your order today and start your subscription with the January, 1936, number.

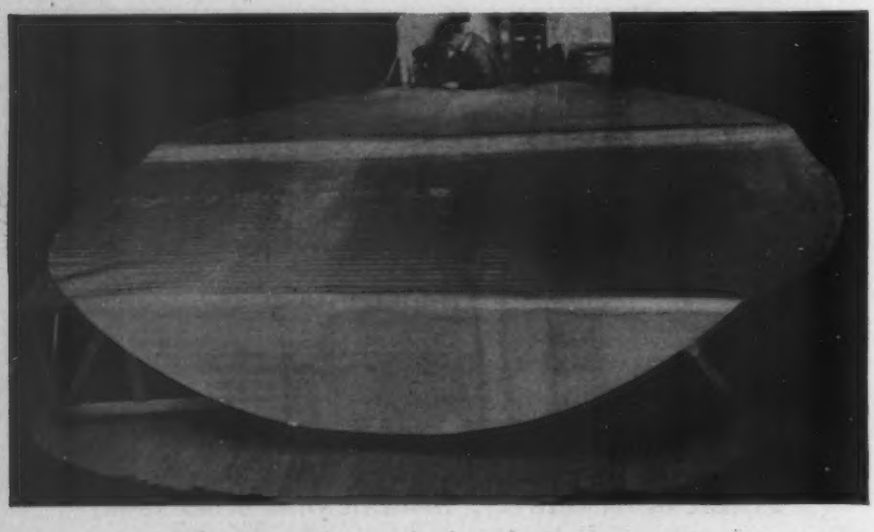
—MAIL THE COUPON BELOW—

each, there is no general practice regarding the layout of the tanks, but in recent years horizontal tank setting has been favored in the Mid-Continent States. Technical and economic reasons for the selection of different types of tank settings are given in the report.

In this publication of 35 pages and 19 figures, the theory of evaporation is discussed, and an explanation is given of the methods of determining evaporation losses. Modern equipment and methods for reducing evaporation losses of petroleum in bulk-storage stations are illustrated and described, and data are given on actual tests on bulk-station tanks showing the extent of the losses from tanks under various conditions of construction and operation. Suggestions are given also as to quantities of lost gasoline fractions that may be expected in filling and emptying storage tanks and in loading delivery trucks. The tests were made on tanks equipped with relief valves operating under various pressures and vacuum, combination gage-hatches and vapor-relief valves, floating or "wiper" roofs for tanks, and other vapor-saving devices.

Other sections of interest and value to the bulk-station operator deal with the use of light-color paints, insulation and pressure to reduce evaporation losses, pressure-tight tank-gaging devices, and breather bags or steel balloons.

Technical Paper 565, "Reduction of Evaporation Losses from Gasoline Bulk-Storage Stations," by Ludwig Schmidt and C. J. Wilhelm, can be obtained from the Superintendent of Documents, Washington, D. C., price 5 cents.



ONE PIECE FILTER BLANKETS up to 20 ft. IN DIAMETER . . .

Benzene in Natural Gas

BUREAU of Mines Report of Investigations 3293, by Shrenk, Yant and Pearce, is the first published account of the finding of benzene in natural gas and in natural gas condensates. Using the calorimetric method recently developed at the bureau the presence of benzene in several paraffins of natural origin was demonstrated. The work is of interest from the viewpoint of origin and subsequent thermal environment of gas and petroleum.

Natural Gas Flow Through High-Pressure Lines

RESEARCH on the flow of natural gas through high-pressure transmission lines conducted over a period of several years by the United States Bureau of Mines, Department of the Interior, with cooperative assistance from the Natural Gas Department of the American Gas Association, is the subject of Bureau of Mines Monograph 6, which has just been issued. In the course of the study 79 flow tests were made on 29 commercial pipe lines, totaling 757 miles of pipe in the principal natural-gas areas of the country with diameters ranging from 6 to 22 inches and operating pressures from 30 to 600 pounds per square inch. The larger-diameter lines that were free from condensates and other foreign materials and were operating under steady flow conditions delivered gas at metered rates which agreed more closely with rates calculated from the Weymouth pipeline flow formula than with those calculated from any of the other formulas studied. In almost every test, under these conditions, the volume calculated from the Weymouth formula was within a few percent of the metered delivery.

During the review of existing data pertaining to the flow of natural gas through pipe lines, it was found that the several pipe-line flow formulas developed by different investigators, which differ mainly in the methods of considering the coefficient of friction, gave widely varying results when applied to problems of pipe-line design. Comparisons were made of the relationship between the coefficients of friction and the internal diameter of the pipe as expressed by the pipe-line flow formulas and as determined from the tests made during the investigation. The coefficient of friction tends to decrease slightly with increasing diameter of pipe. The curve based on the Weymouth formula for the relationship between the coefficient of friction and diameter of the pipe when applied to the lines larger than six inches in diameter agreed closely with the average of the experimental data and satisfied the test data as well as any curve that could be drawn through the plotted points.

Further analyses of the data from

the flow tests on commercial lines, together with the results of laboratory investigations and tests on a small experimental pipe line, indicate small variations in the coefficient of friction, depending upon the velocity, density and viscosity of the gas, and the diameter of the pipe. A mathematical analysis of the variations observed in the calculated coefficient of friction was made on the basis that the coefficient of friction for the flow of any fluid through a circular pipe is some function of the Reynolds criterion—the pipe diameter multiplied by the velocity and density of the fluid divided by the viscosity of the fluid.

The authors of this joint report, T. W. Johnson and W. B. Berwald, of the Petroleum and Natural Gas Division, Bureau of Mines, have arranged their text, comprising 120 printed pages and 25 figures, in an understandable and accessible form. First there is a listing of pipe-line flow formulas used by different investigators with citations to original sources; second, the authors discuss the flow tests they made on commercial and experimental pipe lines, including methods of testing and of analyzing flow data; and third, there is a discussion of the application of flow data and equations to commercial pipe-line transportation problems. The main text of the monograph is followed by appendixes giving detailed mathematical development of formulas, including derivation of general formulas for flow of natural gas through pipe lines, the Reynolds criterion of the coefficient of friction, formulas having the coefficient of friction expressed as a function of the Reynols criterion, and derivation of special formulas for designing pipeline systems consisting of parallel lines. There is also an appendix of tables and formulas, and one describing the pipe lines that were tested. Monograph 6 presents in one volume all of the important material pertaining to the subject of pipe-line flow developed in accordance with the original intent of the cooperative project.

Engineering considerations that are discussed in various sections of the monograph include the effect on delivery capacity of liquids and rust scale in pipe lines, sources and removal of liquids, variations in ground temperatures, design and location of drips, corrosion of lines, stored gas in pipe-line systems, effect of differences in elevation at inlet and outlet, and types of construction and equipment. The report also discusses studies that were made of the physical and chemical properties of natural gas that influence flow through pipe lines, including determination of the chemical compositions, deviations from Boyle's law, and the absolute viscosities of the natural gases in the various pipe lines tested.

The monograph points out that the value of applying many minor corrections in pipe-line flow calculations, such as those due to small differences in elevation at the inlet and outlet of the line, reduced diameter fittings, bends, right-angle turns, metering stations, drips, type of joints, and lengths of pipe between joints, deviations of natural gas from Boyle's law, and variations in the viscosity of natural gas, often is greatly diminished because of conditions pertaining to individual lines, such as unsteady rates of flow, storage or drainage of gas, the presence of condensates, rust, and foreign material in the line, and the variations in roughness of the interior walls of different lines. The effect of such conditions often is many times greater than the sum of all of the measurable corrections and, for practical purposes of design, minor corrections may be neglected in the flow formulas.

The American Gas Association, under the cooperative agreement with the Bureau of Mines, bore the cost of printing Monograph 6, "Flow of Natural Gas Through High-Pressure Transmission Lines." Copies are on sale by American Gas Association, 420 Lexington Avenue, New York City, price $1.00.

Petroleum Exposition To Have Oil Museum

AN OIL MUSEUM, containing working models of the development of the oil industry, is being planned by the International Petroleum Exposition.

According to W. B. Way, general manager, the Scientific and Technical Committee under Chairman W. A. Schlueter, is making arrangements to have some of the models on exhibition at the Ninth International Petroleum Exposition in Tulsa, May 16 to 23, 1936.

"It will take five to ten years to complete the exhibits which the committee is planning and it is highly possible

"SARCO STEAM TRAPS—

TURNED AN EXPENSE INTO A PROFIT!"

"Unequal heating of our presses, due to some of the multiple platens becoming air-bound, often resulted in ruined goods.

"But that's all done with, since we put a separate Sarco Steam Trap on each supply line and drain.

"When you compare our previous expensive losses with the small cost of these traps—the Sarco Steam Traps have paid us a big profit."

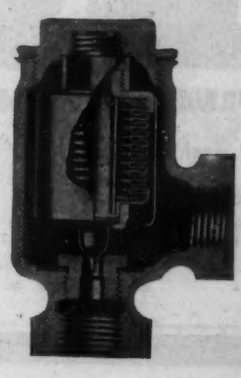
Machines cannot operate at their rated capacity if the flow of live steam is interrupted by air and condensation.

By installing Sarco Steam Traps on every machine, condensation and air will be removed as fast as formed and allow a steady flow of hot, dry steam. No water will be held up in the coils of one unit by back pressure in the return piping from another machine, which happens with large centrally located traps.

Individual trapping also prevents waste of heat by radiation from long connecting lines.

Sarco Traps are made for pressures from 0 to 200 lbs. Try one for 30 days on us. If not satisfied you may return it.

Write for catalog S-95.



SARCO COMPANY, Inc.

183 Madison Avenue, New York, N. Y.

Branches in Principal Cities

Sarco Canada Limited, Federal Bldg., Toronto, Ont.

FOR FORTY FOUR YEARS

For over four decades, confidences in our ability to fulfill each and every responsibility have never been misplaced.

FLUOR CORPORATION
LTD.
909 East 59th St., Los Angeles, Calif.
909 McCormick Bldg., Chicago, Illinois
3162 Edwards St., Alton, Illinois
1406 Esperson Bldg., Houston, Texas
719 McBirney Bldg., Tulsa, Oklahoma
220 East 42nd St., New York City, N. Y.

that a special building may eventually be built to house the exhibits," said Way.

"The exhibits will portray a development of each of the major divisions: production, transportation, refining and marketing. Models of the earliest crude machinery, equipment and methods will be compared with models of improved machinery, equipment and methods each step down to the present time."

"Such a museum should not only be of vast interest and importance to the oil industry but to the general public as well."

Oil companies and firms which have models they no longer are using are asked to contribute them to the museum collection. Way requests such firms to write the Exposition. The museum would become a part of the non-profit International Petroleum Exposition plant, which is owned and controlled by the oil industry.

The Ninth Exposition, with more than 86 percent of the exhibit space already sold, will be the largest in the history of the oil show, believes Way. Large firms, particularly the supply houses, are planning larger exhibits, much of it being heavy drilling equipment. Marketing exhibits will also be larger.

▼ PLANT ACTIVITIES ▼

Sale: Bennett Refining Company, Houston, recently formed by Frank W. Bennett, president, and Clyde V. Shuford, vice president, has purchased the two former Phoenix Refining Company plants at Houston. The deal includes refineries, two tracts of land, a connecting pipe line, oil equipment, leases and a quantity of crude. Plans call for the modernization of the refining facilities and installation of a modern cracking unit.

Refinery: The Swanson Company, Battle Creek, Michigan, headed by Elmer Swanson, Swanson Oil Company, has let contract to Miller Engineering Service, Chicago, for construction of a new 1500-barrel skimming plant. The company is capitalized at $150,000.

Refinery: Inland Refining Company, Pontiac, Michigan, started work last month on its new 1500-barrel skimming plant. E. G. Guy, designer and builder of several Michigan refineries, has supervision of construction. Completion date is January 1.

Resume: Hutchinson Oil & Refining Company, Hutchinson, Kansas, is reported planning to repair and modernize its 1500-barrel skimming plant with view to resuming operations later this month. Plant has been idle for about two years.

Enlarge: Kent Refining Company, Grand Rapids, Michigan, has added a 70-foot fractionating column to increase capacity from 1000 to 1500 barrels per day.

Improvements: Naph - Sol Refining Company, Muskegon, Michigan, following completion of a Dubbs cracking unit, has erected a new office building and new boiler plant, to cost $35,000. This company's improvement program this year has cost about $250,000 and it is the first refinery to install cracking facilities in the Michigan refining district.

Plants: The British Coal Distillation, Ltd., has given rights to use of its process in Canada. Under agreement, Albert Grant, Kitchener, Ontario, is to form two companies for construction of eight distillation plants of 450 tons of coal daily capacity. Two plants are to be erected at once. Construction will be by Canadian Vickers Construction Company, Montreal.

Refinery: Standard Oil Company of California, through its subsidiary, Bahrein Petroleum Company, will carry out contract agreements through establishment of a new refinery on Bahrein Island, Persian Gulf, to produce gasoline, kerosene, Diesel oil and fuel oil.

Enlarge: Sinclair Prairie Oil Company at its Greggton natural gasoline plant, East Texas field, has added four 170 horsepower compressors, bringing total number to 22. A new battery of tanks and tail gas absorber recovery unit have also been added. Present capacity reported at 18,000,000 cubic feet per day.

Resume: Spartan Refining Company, Shreveport, Louisiana, is reconditioning the plant, which has been shut down during the past year, and is preparing to resume operations. Capacity is 12,000 barrels per day and facilities include a new Gyro vapor-phase cracking, clay treating and polymerization equipment operating under Alco Products, Inc., and Gyro Process Company patents and license.

Enlarge: Old Dutch Refining Company, Muskegon, Michigan, will increase capacity by 50 percent through addition of a new still to be erected according to plans of Dr. Clive M. Alexander, St. Louis, Missouri. Work is scheduled for completion January 1.

Operating: Inland Refineries Corporation, Drayton Plains, near Detroit, Michigan, began operating a 1500-barrel refinery early this month.

Gasoline Plant: Gillilan General Crude Oil Company is completing construction of a compression type natural gasoline plant four miles southwest of Kilgore, East Texas field. Capacity is reported at 12,500,000 cubic feet of gas to produce 60,000 gallons of gasoline daily, taking gas from 1400 wells. Location is on the Tide Water Oil Company's Jerigan lease, Simms survey, Gregg County.

Helium: The Helium Corporation has announced that it will resume operations at its helium extraction plant at Dexter, Kansas. The Thatcher, Colorado, plant owned by the same company remains shut down. The Dexter plant has been inoperative during the past two years.

Operating: Crystal Refining Com-

pany, Carson City, Michigan, started operating a new 2500-barrel skimming plant late in November. Company is headed by Del Fortney.

Refinery: The Wood-Moore Corporation has started construction of a 2000-barrel refinery at Port Lavaca, Texas. Will process 1250 barrels daily when placed in operation but is designed for addition of secondary fractionating equipment to permit operations at 2000 barrels. Equipment provides for production of closely cut naphthas and solvents. Vulcan Steel Tank Corporation, Tulsa, has been given contract for engineering work and materials, with the work under supervision of Ray B. Millard.

Poly Plant: Standard Oil Company of California announced last month that it would proceed with installation of a $600,000 polymerization-hydrogenation unit at the Richmond refinery. Polymerization unit is Universal Oil Products Company type. Aviation fuel of 100 octane or higher is to be produced.

Furnaces: Dickey Oil & Refining Company, McPherson, Kansas, has given contract to Webster Engineering Company, Tulsa, for reconstruction of furnaces at reported cost of about $35,000.

Dismantle: Sinclair Refining Company plans to sell its El Paso, Texas, refinery (Rio Grande Oil Company) for dismantling and sale of equipment.

Refinery: W. J. Sovereign, Saginaw, Michigan, has announced plans for construction of a 1500-barrel skimming plant.

Refinery: Lakeland Refining Company, East Lansing, Michigan, is reported having plans drawn by Miller Engineering Service, Chicago, for a skimming plant of unannounced capacity. Estimated cost $100,000.

Distillation: Sweet Oil Refining Company, Max Pray, president, Wyman, Michigan, awarded contract to Miller Engineering Service, Chicago, for construction of 1200-barrel distillation unit.

Hydrogenation: Mitsubishi Mining Company, Ltd., Japan, announces installation of a low temperature carbonization plant at its Naihoro colliery, west coast of Karafuto, and development of process for hydrogenation of coal.

Operating: Western Refining Company, Chase, Kansas, is operating its recently purchased refinery at 600 barrels daily. The skimming plant has recently been revamped and repaired.

Dismantling: Texas Railway Equipment Company, Houston, purchased on October 19 the Texas Pacific Coal & Oil Company's 3000-barrel crude skimming and asphalt plant at Wynnewood, Okla. The plant has been inactive for several years, and will be dismantled.

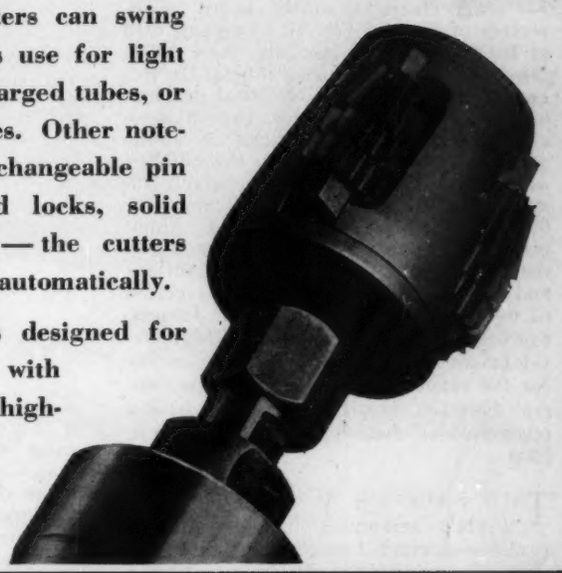
Refinery: Texas Pacific Coal & Oil Company, Fort Worth, has suspended operation of its crude skimming and cracking plant at Fort Worth through having arranged for the processing of its crude at Marathon Oil Company's plant on a nearby site. The former will continue to operate its oil and grease compounding unit at Fort Worth, using Ranger crude bright stock material to be delivered by Marathon Oil Company, and will also maintain active operation of its 1000-barrel capacity crude skimming plant near Caddo, Texas.

Heads-you win!

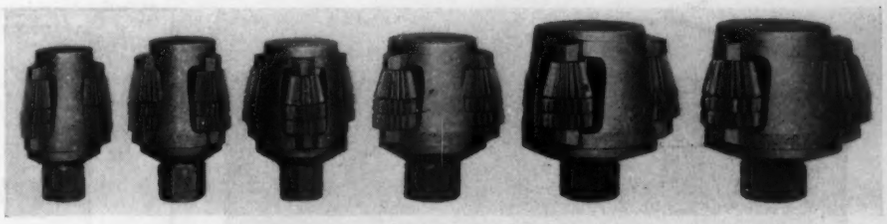
With Liberty heads, you are sure to win the battle with carbon deposits in still tubes.

In this Liberty Type "GR" (Great Range) head the cutters can swing far out, permitting its use for light and heavy coke, in enlarged tubes, or in several sizes of tubes. Other noteworthy features: interchangeable pin blocks, separate head locks, solid connections, self-feed — the cutters bore into the carbon automatically.

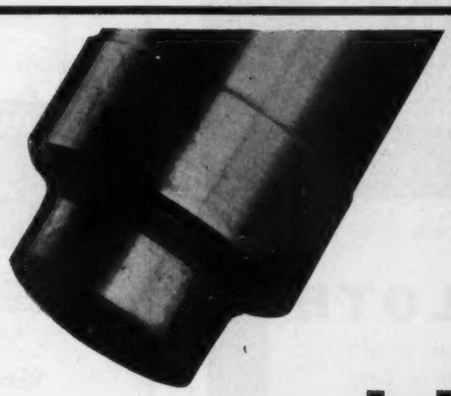
The "GR" head is designed for heavy duty for use with Liberty high-powered high-speed motors, such as the "OB" motor, illustrated.



SIZES of LIBERTY "GR" CUTTER HEADS



2½" To 3½"	2⅞" To 4"	3 3/16" To 4 7/16"	3 13/16" To 5 5/16"	4¾" To 6½"	4 15/16" To 6 13/16"



Don't forget Liberty service— experienced men in district offices all over the country at your service whenever you say the word.

LIBERTY
MANUFACTURING CO.
JEANNETTE, PA.

Z-1158

AN ELLIOTT COMPANY ORGANIZATION

▼ BUSINESS NOTES ▼

CHARLES W. EAST, formerly of the Birmingham, Alabama, office of Republic Steel Corporation, has been named assistant manager of sales in the company's pipe division, succeeding George E. Clifford recently appointed district sales manager in the Los Angeles territory.

EDWIN WILBUR RICE, JR., 73, honorary chairman of the board of directors of General Electric Company, died at his home in Schenectady, New York, November 25, after a long illness. He was one of the pioneers of electrical development in the United States, and in association with the late Charles A. Coffin played a conspicuous part in the building of General Electric. He was largely instrumental in adding to the company's technical staff the late Charles P. Steinmetz; he encouraged the investigation by the company of the Curtis steam turbine and gave it a fair trial through a period of uncertainty until it became the foundation of a vast electric power system development; and he was chiefly responsible for the establishment of the famous General Electric research laboratory, having recommended that step to the directors in 1900.

THE BABCOCK & WILCOX COMPANY announces that, to provide a closer contact between customer and plant, the refractories division sales office for the Southeastern district has been transferred from Atlanta to the works at Augusta, Georgia.

ANNOUNCEMENT is made that H. D. Leisenring has joined the sales force of Pittsburgh Equitable Meter Company and its subsidiary, Merco Nordstrom Valve Company. Following graduation from LaFayette University in 1929, Leisenring was employed by Pennsylvania Pump Company of Pittsburgh, working in various capacities for that organization in Pittsburgh, Chicago and Baltimore. In the last named city he was district manager in charge of sales for the Eastern Seaboard. In his new connection he will operate from the home office in Pittsburgh and sell and service Pittsburgh gasoline meters and Nordstrom valves.

H. D. LEISENRING

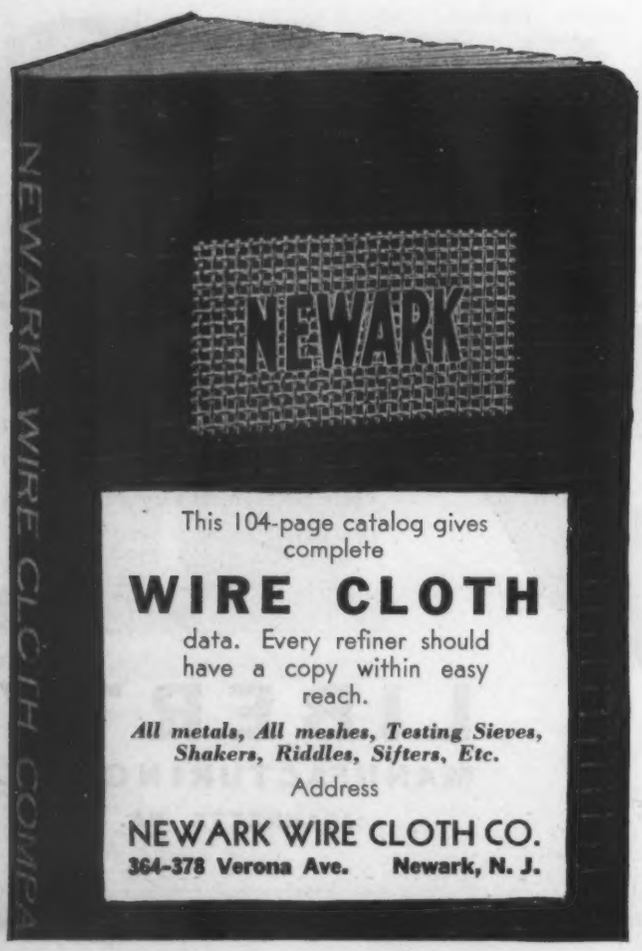
EXECUTIVE offices of Link-Belt Company, Chicago, have been moved to the Bell Building, 307 N. Michigan Avenue, where they will occupy the entire twenty-third floor, and the north half of the twenty-first floor.

R. H. GARDNER, formerly division manager of the Washington office, A. M. Byers Company, has been transferred to Pittsburgh as manager of steel pipe sales.

Simultaneously, E. L. MacWhorter, formerly manager of the company's Philadelphia division, moves to the Munsey Building in Washington, where he will head the combined activities of both divisions now known as the Washington division. District representatives will be maintained, as in the past, in Baltimore and Philadelphia, the latter address now being 1212 Commercial Trust Building.

HENRY S. MORGAN and Robert C. Stanley have been elected members of the board of General Electric Company to fill vacancies. Thomas Cochran, former director, has resigned because of ill health. Morgan was until recently a partner in the firm of J. P. Morgan and Company, and is now a director and executive officer of Morgan, Stanley & Company, Inc. Stanley has been president of The International Nickel Company since 1922. He represents various metal and petroleum interests in the United States and Canada.

A. A. HOLLANDER has been appointed district sales representative in the New York trade area for The Medart Company, with offices at 1265 Broadway, New York City.



This 104-page catalog gives complete

WIRE CLOTH

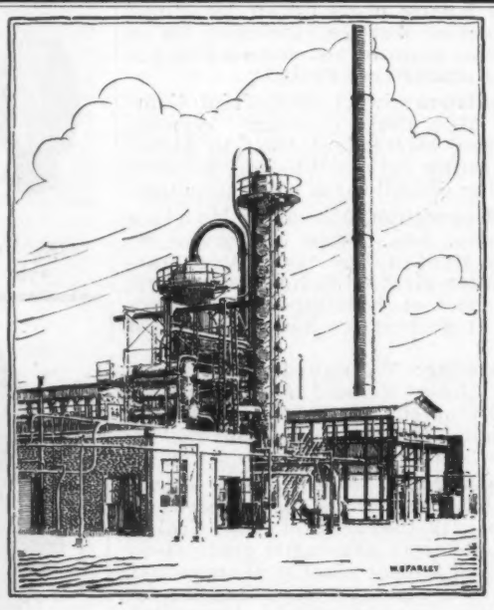
data. Every refiner should have a copy within easy reach.

All metals, All meshes, Testing Sieves, Shakers, Riddles, Sifters, Etc.

Address

NEWARK WIRE CLOTH CO.

364-378 Verona Ave. Newark, N. J.



REFINERY DESIGN, FABRICATION, AND ERECTION

Send us your inquiries

J. P. DEVINE MFG. CO., Inc.

Subsidiary of Mt. Vernon Car Mfg. Co.

MT. VERNON, ILL.

PITTSBURGH EQUITABLE METER COMPANY has added two new members to the Research and Product Development Section of its Engineering Department at Pittsburgh. E. M. Cloran,

E. M. CLORAN

who was graduated in engineering, from Harvard University in 1928, comes to his new position with a valuable background of practical engineering experience. First employed following graduation by Stone and Webster Corporation as a junior engineer, he advanced by successive steps to become a plant engineer for Atmospheric Nitrogen Corporation of Hopewell, Virginia, and more recently held a sales engineering position with the Consolidated Ashcroft Hancock Corporation of Bridgeport, Connecticut.

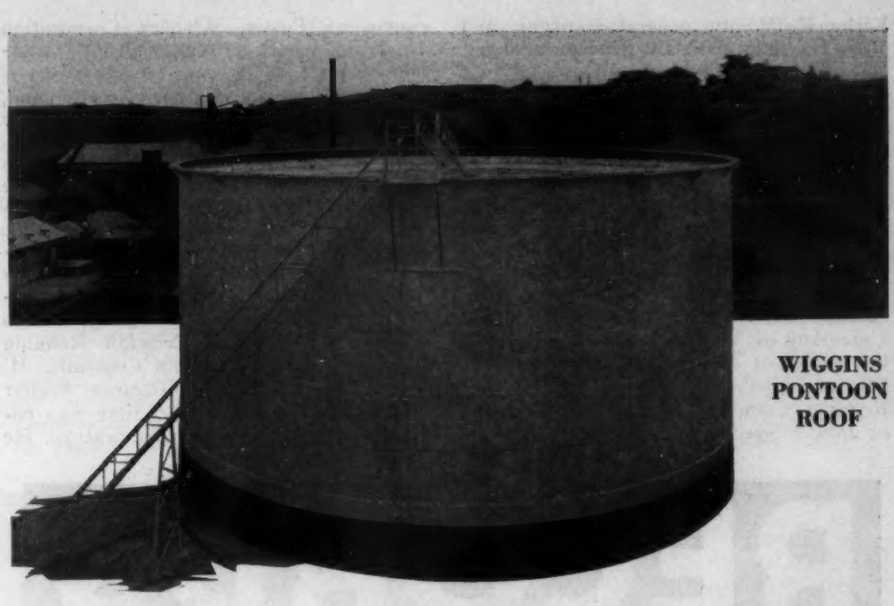
H. J. EVANS

H. J. Evans, graduated with a degree in Mechanical Engineering at University of Oklahoma in 1933. Returning to school the following year he took post graduate work in Petroleum Engineering. Since graduation he has been employed by the Geological Department of Carter Oil Company and Humble Oil & Refining Company.

Cloran and Evans will work in the physical laboratories in Pittsburgh under the direction of Chief Engineer Allen D. MacLean and the immediate supervision of Research Head L. M. Van der Pyl.

DUE to the increased volume of business which it has undertaken during the year 1935, and based upon the general outlook in the industry, Alco Products Incorporated, a division of American Locomotive Company, has found it necessary to add to its organization.

Joseph Davis, president, announces the following appointments recently made effective: H. Robert Swanson, vice president in charge of sales and engineering;



WIGGINS PONTOON ROOF

Getting on Top of the Evaporation Problem

EVAPORATION of oil in storage used to be an unavoidable waste. But step by step, the industry has moved toward a solution of this problem. Today there is no need for suffering losses from any tanks.

During our years of specialized work in this field, we have developed roofs for flat-bottom tanks which stop evaporation either on working tanks or standing storage and pressure storage tanks of various types to hold the more volatile products which may boil at atmospheric pressure.

We can help you get on top of your evaporation problem. Write our nearest office for information on the best types of tanks to meet your particular conditions.

CHICAGO BRIDGE & IRON WORKS

Dallas	1455 Dallas Athletic Club Bldg.	New York	3302-165 Broadway Bldg.
Houston	2919 Main Street	Philadelphia	1608-1700 Walnut St. Bldg.
Tulsa	1626 Thompson Bldg.	Boston	1529 Consolidated Gas Bldg.
Birmingham	1548 North Fiftieth Street	Cleveland	2234 Rockefeller Bldg.
Chicago	2463 Old Colony Bldg.	San Francisco	1051 Rialto Bldg.
Detroit	1520 Lafayette Bldg.	Los Angeles	1434 Wm. Fox Bldg.

Fabricating plants in Chicago, Birmingham and Greenville, Pa.

TOP: Wiggins Pontoon Roof on a 40,000 bbl. gasoline storage tank.

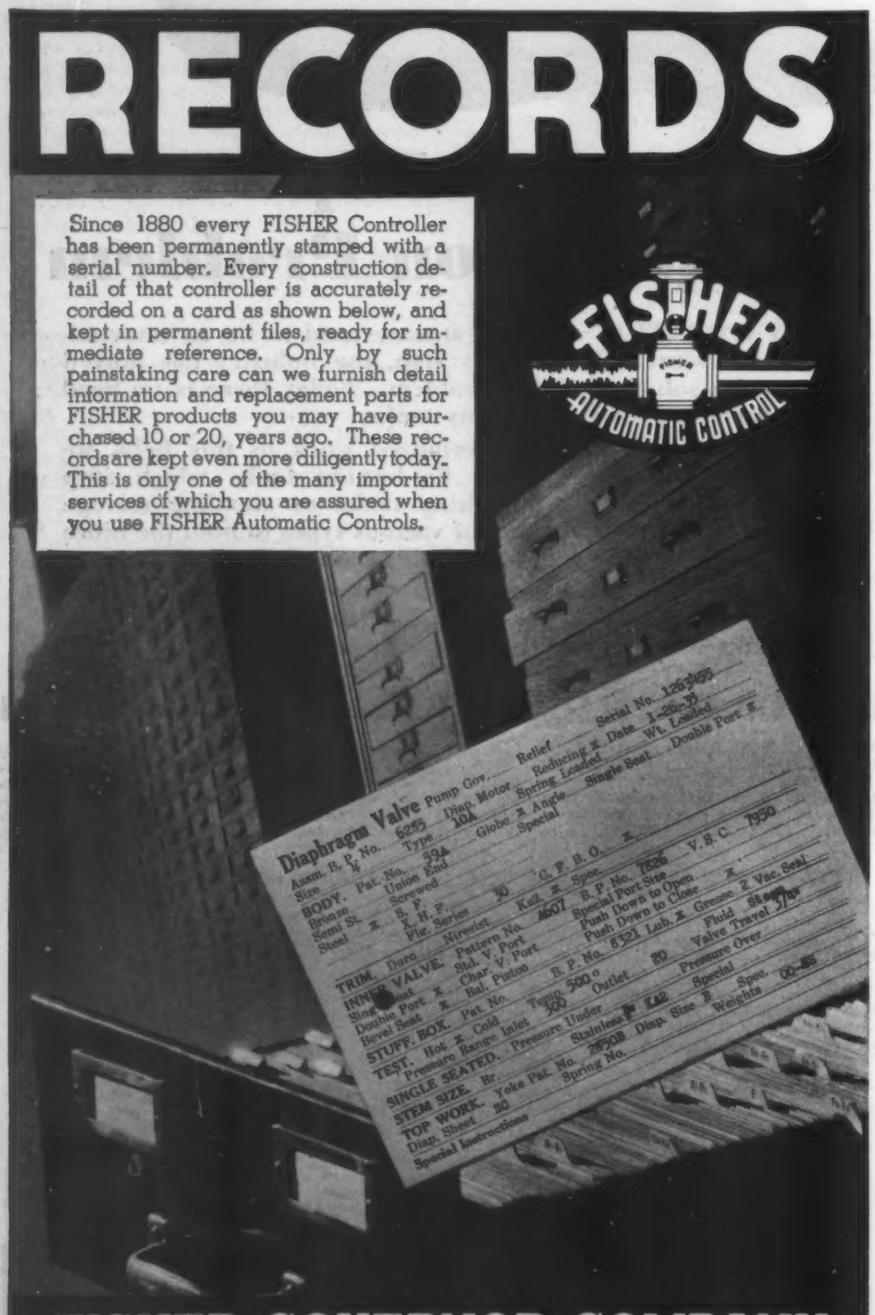
RIGHT: 20,000 bbl. Hortonspheroid for 15 lbs. per square inch internal pressure

Kirby K. Wyatt, general manager, and John H. Erter, assistant general manager.

Swanson has been vice president of Alco Products Incorporated, primarily in charge of engineering, since its formation late in 1930. He is a native of New York state, obtained his higher education at Hobart College from which he was graduated in 1919, and the Massachusetts Institute of Technology from which he was graduated in Chemical Engineering in 1921. Swanson thereafter was employed by Proctor & Gamble Company at Cincinnati, took special graduate work at the University of Wisconsin and was later in the employ of The Atlantic Refining Company at Philadelphia. He left The Atlantic Refining Company to enter the employ of Power Specialty Company, the predecessor of Foster Wheeler Corporation (in 1925), where he remained until entering Alco Products.

Kirby K. Wyatt was born at Highland, Kansas, where he received his preparatory education. He was graduated from Kansas State College in 1911 with a degree in engineering. For the past six years he has been general manager of Silica Products Company, Kansas City, Missouri. Prior to his engagement with Silica Products Company, he was associated successively with the General Electric Company, Allen Machine Company, Fargo Engineering Company, Sinclair Refining Company, Celite Products Company, M. W. Kellogg Company, Doctors Walter and Roy Cross, and for a time was engaged in private engineering practice. He is a member of the American Society of Civil Engineers, and Registered Professional Engineer, Kansas.

John H. Erter was born at Antwerp, Ohio, and received his early education in the public schools at Shelby, Ohio. In 1910 he moved to Tulsa, Oklahoma, where he attended high school, later entering the School of Petroleum Technology, University of Oklahoma. After graduation in 1918, he entered the Chemical Warfare Service, as a control chemist at Willoughby, Ohio. Following his discharge from war service, he was associated with Cosden and Company, Carter Oil Company, Anderson-Pritchard Oil Corporation, Marland Refining Company and Foster Wheeler Corporation. Since March, 1931, he has been contract engineer of Alco Products, Incorporated, supervising mechanical design, construction and operation.


RECORDS
Since 1880 every FISHER Controller has been permanently stamped with a serial number. Every construction detail of that controller is accurately recorded on a card as shown below, and kept in permanent files, ready for immediate reference. Only by such painstaking care can we furnish detail information and replacement parts for FISHER products you may have purchased 10 or 20, years ago. These records are kept even more diligently today. This is only one of the many important services of which you are assured when you use FISHER Automatic Controls.
FISHER
AUTOMATIC CONTROL
Diaphragm Valve
FISHER GOVERNOR COMPANY
2334 E. EIGHTH STREET LOS ANGELES, CALIF.
50 CHURCH STREET NEW YORK, N. Y.
201 SOUTH FIRST AVENUE, MARSHALLTOWN, IOWA

G. H. B. DAVIS has been named director of the Esso Laboratories of Standard Oil Development Company at Elizabeth, N. J., succeeding Per K. Frolich who has been made chief chemist of Standard Oil Development Company. H. W. Fisher, former assistant manager of the Esso Marketers sales engineering department, will succeed Davis as assistant director of the laboratories, which are engaged in research and development work for the Esso Marketers, which comprise the Standard Oil Companies of New Jersey, Pennsylvania and Louisiana and the Colonial Beacon Oil Company, Inc.

THE Edeleanu Company, Ltd., New York, is presently installing a new and much larger research and development laboratory on Long Island. Dr. E. N. Terres, head of the company in America, announces that the first shipment of equipment for the new laboratory has been received and is being placed in the large two story brick building. The equipment was designed in cooperation with and built by E. B. Badger & Sons Company, whose concern is designing and construction agent for Edeleanu units. Equipment includes both small and large scale research and experimental units for the work and study of extraction methods for kerosene, gasoline, lubricating oils and other petroleum products.

THE Rubber Chemicals Division of E. I. du Pont de Nemours & Company announces that the new plant for the manufacture of its synthetic rubber, known as DuPrene, which has been under construction for the past year, is completed and is producing at the rate of approximately one million pounds a year. The plant is located at Deep Water, New Jersey, opposite Wilmington, Delaware, where shipping facilities are available both by rail and water. Since the announcement of DuPrene in 1931 a great amount of technical work has been done in many industries in applying this synthetic product to their needs. Since DuPrene compositions will withstand higher temperatures than those of natural rubber and are more resistant to oils and chemicals and have less tendency to crack when repeatedly stretched and flexed, they soon found wide utilization.

The petroleum industry has become an important buyer of such compositions. The company reports that they are used as inner liners for tubes in

oil and gasoline ship loading hose, gasoline service station hose, gasoline tank truck hose and hose for delivering fuel oil to the home or factory. Packer rubbers and pump pistons of DuPrene composition are used in oil well drilling, and the refineries use it in gaskets and packings.

THE JOHN ZINK COMPANY, manufacturer of oil and gas burners for oil industry and industrial use, has moved to a new location in Tulsa, Oklahoma. It now occupies a fire proof building containing sixty-four hundred square feet of floor space. First floor is devoted to the manufacture and assembly of the many types of John Zink burners. Shop is equipped with the newest type of machinery, and with a decided increase in personnel the production schedule has been stepped up. Second floor of the building is devoted to general offices and display room. Sales policy of the John Zink Company is rather unique in view of the fact that no salesmen are used, all burners being sold through advertising, and to date more than 14,000 burners have been sold.

THE American District Steam Company of North Tonawanda, New York, announces the appointment of Edward A. Hahl to the sales engineering staff. Hahl is prominently known in the water heater and heat interchange equipment field where he has been active for the past 14 years. He will continue to specialize in this field.

A. J. WADHAMS, manager of development and research, The International Nickel Company, Inc., has announced the addition of Herschel V. Beasley to the technical staff. Beasley will make his headquarters in the New York office where his services will be available to the industry at large. His activities will include problems involving the production and application of alloy cast irons. During Beasley's metallurgical experience, he has held responsible positions in the Delco-Remy division of General Motors Corporation, Estate Stove Company, and Centre Foundry and Machine Company. In addition, he has carried on research into steel pouring practice at Mellon Institute of Industrial Research and was a Research Fellow at the United States Bureau of Mines where he was concerned with the physical chemistry of steel making.

CRANE COMPANY, Chicago, announces appointment of H. H. Simmons as advertising manager, effective November 15. In cooperation with other aids to selling, such as exhibits, dealer service, special campaigns, and sales training, he will develop the advertising service so that it can be fitted into the general sales promotional program. To take up his new responsibility, Simmons terminates a nine-year association with Russel T. Gray, Inc., Chicago advertising agency, of which he has been vice president and account executive.

MAINTENANCE ENGINEERING CORPORATION, Houston, Texas, was recently honored as the subject of the house organ, *High Spots*, of Hogan Corporation, sponsors of the Hall System of Boiler Water Conditioning. The entire issue of October 28 was devoted to the work done by Maintenance Enginering Corporation, and its staff of engineers in the prevention of scale formation, as well as removal of old scales, by the controlled use of phosphate in boiler water conditioning.

According to *High Spots* the first carload of Hagan Phosphate was shipped to the Maintenance Engineering Corporation warehouse at Houston on August 8, 1931, after the company had officially become a representative for the Hall Laboratories and Hagan Corporation on August 5, 1931. Since that date Maintenance Engineering Corporation has been a carload distributor of Hagan Phosphate to practically all the boiler plants of any consequence in Texas, chief of which is the petroleum refineries.

On January 8, 1933, Maintenance Engineering Corporation became a marine representative of the above companies with its clientele including the fleets of several large steamship concerns operating in the Gulf as well as the ships and barges of several of the major oil companies.

KELLOGG COMPRESSOR & MANUFACTURING CORPORATION has just been incorporated under the laws of the state of New York to take over all assets of Kellogg Manufacturing Company of Rochester, N. Y. The latter concern has been going through reorganization for the past six months.

J. F. Weller, commonly known as "Sam," has been named president of Kellogg Compressor & Manufacturing Corporation. He was active in the management of the old company during its active rise

Opens The Door To Better Refrigeration

Extremely low temperatures needed in certain refining processes, can be attained with Corinco Cork Pipe Covering. Moulded from ground cork, Nature's own insulation, Corinco Cork Pipe Covering fits snugly, presents a neat appearance, lasts for years without replacements and is the perfect insulation. Refrigeration efficiency can be greatly increased by using Corinco Cork Pipe Covering.

Write for descriptive Price List REF-3.

CORK INSULATION CO., Inc.

General Offices

155 E. 44th STREET, NEW YORK, N. Y.

Factory at **Wilmington, Del.**

Branches in Principal Cities

but has not had his official capacity for two or three years. Associated with him in the new organization will be such old associates as John J. Sharp, H. Ozgood Holland, George B. Collins, Nicholas Arnold and Dan Bohannon. The old representatives in the field, such as O. Arthur Clark, Tracy Outhouse, Niblo, Hamilton and Lee Tuttle with his whole organization will start the new company off with a big drive.

Simultaneously with the announcement of the formation of a new company, was presented for the first time a new line of air compressors which will be a big forward step in design. One of the principal innovations is that the compressor is completely encased in a gun metal covering, trimmed with chromium. This gives it an appearance strictly in keeping with the modernistic service stations that have been erected during the last few years. It also provides an element of safety, as it is impossible to have one's hands or clothing caught in the belt or other moving parts. Ventilation is provided through scientifically designed openings.

ORDERS for new equipment, which embodies the latest developments in machinery and machine tools, have been placed with 12 American manufacturers by Pittsburgh Equitable Meter Company, and its subsidiary, Merco Nordstrom Valve Company.

It has long been the company's belief and policy that the high efficiency and precision workmanship found in Pittsburgh gasoline and oil meters and Nordstrom lubricated plug valves was, to a large extent, due to the superior and advanced design of its manufacturing equipment. The operating heads of the company spent several days at the Machine Tool Show at Cleveland, studying the merits and efficiency of all new equipment to determine which particular type and make would be best suited and would further increase the efficiency of plant operation.

EFFECTIVE December 1, the distribution of The International Nickel Company products in the Gulf Coast, formerly handled by Equitable Equipment Company, will be carried on by Metal Goods Corporation with office and stock in Houston, Texas. Edward Schwartz, who represented The International Nickel Company in this territory for many years, will be associated with Metal Goods Corporation.

ANNOUNCEMENT of the appointment of C. L. Welch, Lee S. Abbott and George E. Fox, as district managers, is made by A. E. Heroux, general manager of the paint division of Aluminum Industries, Inc., of Cincinnati, Ohio.

HERCULES MOTORS CORPORATION, Canton, Ohio, has established a branch factory at Muskegon, Michigan, in the plant formerly occupied by Clarke Sanding Machine Company. Machinery and equipment are being installed.

Much material used by the company is now produced in Muskegon, and additional manufacturing operations will be carried on in the new plant, although final assembly and testing of the company's products will continue at the main plant in Canton.

In addition to the new branch factory in Michigan, the company is greatly increasing its facilities at Canton, Ohio, as a part of the expansion program made necessary by the increased demand for its products.

THE Babcock & Wilcox Company announces the opening of a sales office at 1809 Railway Exchange Building, St. Louis, Missouri. F. C. Brandt, formerly of the Chicago office of this company, is in charge of the new office, which will serve the eastern half of Missouri and the southern section of Illinois.

GRISCOM-RUSSELL COMPANY announces the appointment of Farrell & Jones, 10 High Street, Boston, Massachusetts, as its representative in the Boston territory to handle the sales of G-R evaporators, generator air coolers, fuel oil heaters, and heat transfer equipment for chemical, petroleum refining and general industrial plants, central power generating stations, and marine service.

STRUTHERS-WELLS COMPANY has moved its New York office to the R. C. A. Building, 30 Rockefeller Plaza, New York City.

A. M. LOCKETT & CO., LTD., New Orleans, Louisiana, has appointed O. E. Berg as special representative for seamless tubular products, as manufactured by The Babcock & Wilcox Tube Company. He will make his headquarters at Houston.

THAT'S WHERE YOUR

MONEY GOES!

Every oil man can quickly figure the gallonage loss he sustains every minute that a gauge hatch is held open for hand gauging. The longer the gauger holds the gauge cover open the greater the loss of natural gasoline. Hand gauging of petroleum storage tanks is a costly proposition. S. &. J. Automatic Gauges eliminate this vapor loss.

Beside's the gallonage loss there is also a waste of the gauger's time in climbing to the top of the tank—taking a reading and climbing down again—to say nothing of the hazard of asphyxiation and damage to tank roofs. When S. & J. Automatic Gauges are employed the reading is taken from the ground—a hundred times as fast—and with absolute safety.

If gallonage inventory figures are to be useful the readings of gauges must be correct. An error of 1/8" in gauging a 50' diameter tank means an inventory error of 153 gallons. The same error in gauging a 150' diameter tank means an inventory error of 1377 gallons. The human element entering into hand gauging makes accuracy very uncertain. The accuracy of S. & J. Automatic Gauges is limited only by the ability of your gauger to take a hair line reading of the tape.

The S. & J. Automatic Tank Gauge shown at the left is but one of a large number of conservation and safety devices that are illustrated and described in our new catalog No. 52-B. Write for a copy of this catalog today.

SHAND & JURS CO.

BERKELEY, CALIFORNIA

295 Madison Avenue, New York, N. Y.

SHAND & JURS

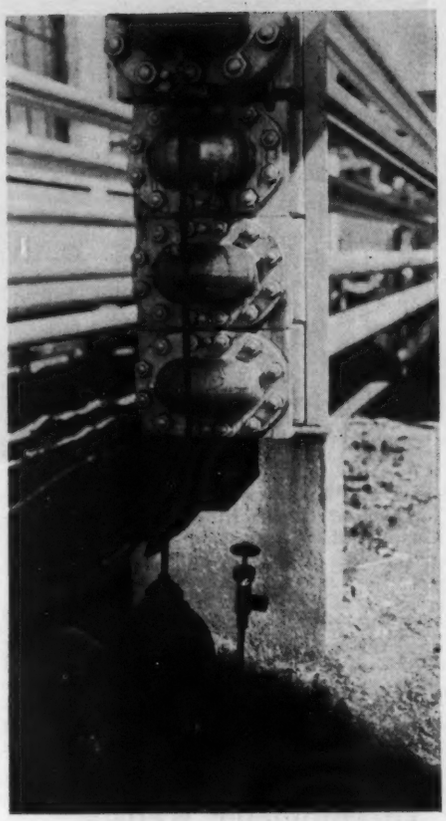
▼ IDEAS ▼

Robot Sample Carrier's Name is "Oscar"

FREEDOM OIL WORKS COMPANY, Freedom, Pennsylvania, maintains an analytical laboratory in the second floor of a building in the plant, which would otherwise work considerable hardship upon the sample gatherer, if some one in the refinery had not had an idea. Because of this idea, "Oscar" was born. "Oscar" is a sample boy of the robot type. He is so designed that, with a basket suspended from a steel cable, the sample gatherer can place his sample bottles, cans and other containers in this basket, ring the laboratory and the samples travel to the laboratory window and into the room where the routine chemist takes them to find out what the operators in the plant are doing to the lubricating oil and other products.

Inside the window is an electric motor geared to a grooved pulley, which in turn carries the cable for the basket. When the basket arrives at the window, a switch is tripped which cuts off the current and throws on a brake to hold "Oscar" in place. After the samples are removed, the brake is released, and "Oscar" rides back, by gravity, to the other end of the journey, ready for another load of bottles.

—J. C. A.



Heat Exchanger Drip

Ammonia Cylinder Rack

MID-WEST REFINERIES, INC., Alma, Michigan, employs an ammonia cylinder rack which prevents connections from being broken off and holds the cylinders always in the same position.

The rack is made by using pipe for the supporting legs, one set for each cylinder, and larger pieces of pipe used, welded to the legs to form a cradle, which receive the cylinders. The rack is made so the cylinders lay slightly at an angle, which provides ease of handling. After two cylinders were placed in position, connections were cut so that when removing empties or replacing with full cylinders the connections always fit. Gates near the cylinder outlet connections prevent waste of gas when making connections.

No wrestling around with cylinders is necessary to force the connections to come to the proper place. All that is necessary, is to remove the empty drums and replace with fresh cylinders, flange up the unions and start using the ammonia.

Heat Exchanger Drip

SHORTLY after the high pressure, low temperature fractionation plant of Gas-Oil Products Inc., was started up near Lucinda, Pennsylvania, condensates in the upper part of a tubular cooler caused vibration. Pressures are high on this unit, running up to 1500 pounds, and, if a slug of water, partly frozen, should break loose, the impact was feared because of the chance of rupture of the return bends.

Willard Shreffler, superintendent of the plant conceived a method of bleeding the liquid off in the first section of the cooler. He accomplished it by using one of the company's liquified petroleum gas bottles, or drums, buried in the ground and connected to the return bend with a short piece of heavy steel pipe. Another hole was drilled and tapped in the bottom of the cylinder to which the drain line was connected. Heavy forged steel needle valves were used, both on the drip line and the drain. Since this drip has been placed in operation, no vibration has been observed. —J. C. A.

Insuring "One-Kick" Starting

WINTER months bring more than their share of added grief to the men who are responsible for uninterrupted operation of power units, but much of this trouble often can be sidestepped or eliminated if a little thought is given the trouble beforehand.

One of the causes of much delay and even process shut-down is the failure of air-started prime movers to "kick off" on the first charge of air, due to condensation within the cylinders while expanding considerable quantities of cold air within them. Tracing this starting trouble leads directly, in cases where the engine is direct-connected to a pump or compressor without intervening clutch, to the added resistance of the heavy gear compound within the reduction gear case. So stiff is this compound that the engine, though rotating, will not attain sufficient speed to set up its proper operating cycle, and it must be dried and a second attempt made.

If the engineer or operator will jack or bar his engine backward until the pinion has cleared about half of the big drive gear, and the starting air then turned on, the pinion will not have to clear excess grease from the big gear during the first two or three revolutions of the engine crankshaft, by which time the flywheel will have acquired sufficient momentum to carry the unit past succeeding firing points fast enough for the engine to take up its work. Try it some cold morning, and see how well the scheme works.

ELTON STERRETT,
Longview, Texas.

Barrel "Upender" Saves Labor

AFTER empty barrels are de-dented, cleaned and painted, they are placed in an oven to dry. As they emerge from this oven, they are dropped on an automatic conveyor which moves them to any floor of the building desired. They come from the drying oven lying down, but to travel on the conveyor, they must be turned upon end.

An engineer in the Freedom Oil Works Company plant designed an apparatus which automatically changes position of the barrels without the aid of hands. This device was made from discarded electrical conduit, welded in such shape that a standard barrel will fit easily in the basket, but not roll through. It is hinged off center, so the weight of the barrel will trip it, making the container turn end up on the endless conveyor. It it counter weighted at one side so it will return to position for another barrel as soon

Simple rack for ammonia cylinders saves time and trouble.

BEST FOR CLEANING TANK CARS

Either for removing oil stains, or for stripping road dirt and traffic film from aluminum painted tank cars, there is nothing that can compare with the NEW cleaning methods specially developed by the Oakite Research Division for this work. Surfaces are CLEAN and streak-free after washing. There is no harmful effect on the paint. And important to you is the fact that cleaning the safe Oakite way is economical. Ask us for helpful data on this and other refinery cleaning operations. Write today.

Manufactured only by

OAKITE PRODUCTS, INC.

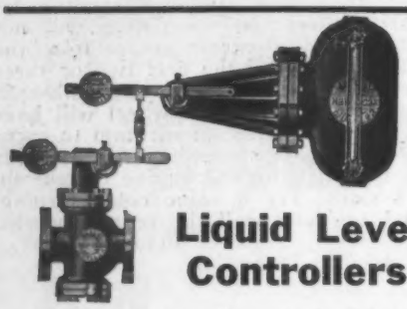
50B Thames Street, New York, N. Y.

Branch Offices and Representatives in all Principal Cities of the U. S.

Since 1909 the Standard of Cleaning Quality

OAKITE

Industrial Cleaning Materials and Methods



Liquid Level Controllers

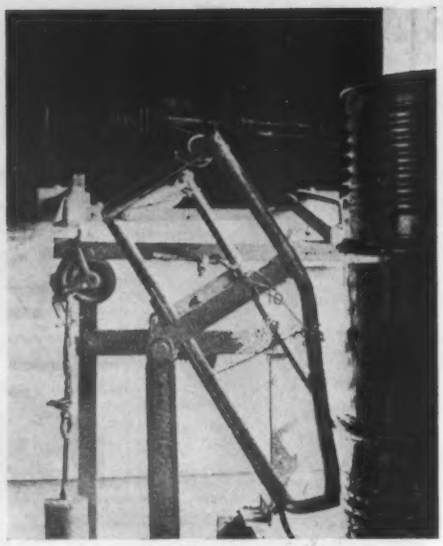
For the accurate control of liquids in tanks or other vessels. Direct connected or remote control; ball bearing spindle and easy-to-pack stuffing box; rotary or sliding valve. Write for special bulletin C-9.

KIELEY & MUELLER, Inc.
34 West 13th St., New York, N. Y.
Plant: NEWARK, N. J.

K and M

PRESSURE AND FLOW CONTROL APPARATUS

Pressure Regulating Valves
Air Pilot Operated Valves
Balanced Valves
Back Pressure Valves
Pump Governors
Steam Traps
Liquid Level Controllers



Barrel "Upender" used in reconditioning plant at the lube division of Freedom Oil Works Company, Freedom, Pennsylvania.

as the one just tripped moves up the conveyor. It could, perhaps, be elaborated upon by providing roller or ball bearing trunnions, but it has performed so sucessfully since it was installed tht the operators do not wish to change its form. —J. C. A.

Thermometer Wells

WHEN thermometer wells, or thermocouple wells, are installed in the usual manner of employing a boss welded to a pipe line, they wear out rapidly in the threads if the device is taken apart often for cleaning or inspection.

To overcome this difficulty try the following procedure. Instead of the usual welded boss, at the point in the line where the thermometer is desired cut a hole through the line and weld in a nipple extending through the pipe with a threaded end on the upper part. Next, a bolted ground joint flange is used, one half of which is screwed to the nipple and the other half use for the insertion of the well. The packing gland on the thermometer or thermocouple is used in the usual manner to secure the unit to the upper half of the flange. When it is necessary to remove the unit from service the two bolts of the union or flange are loosened and the thermometer or thermocouple may be taken out for cleaning and without disturbing the threads on the nipple—thus lengthening the life of the unit.

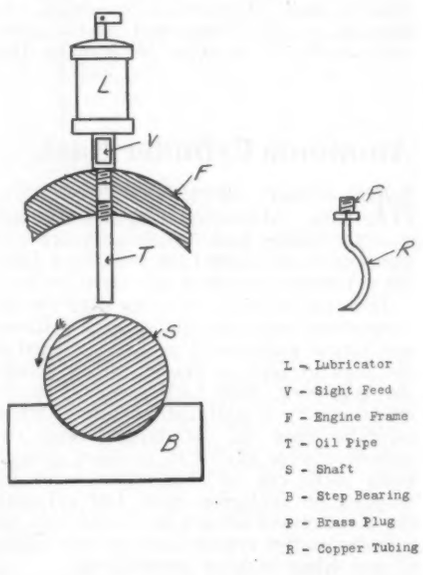
J.L.G.

Thermometer Well

Curing Ailing Oil Feed

NO matter how generous the amount of lubricant run through the sight feeds over the end bearings of a battery of six-cylinder vertical gas engines, a decided knock sometimes indicated the shortage of oil, while at others the trouble was signalled by excessive heating of the main shaft where it emerged from the crankcase.

The bearing showing the trouble was built with its lower half projecting four inches beyond the upper or cap half, so as to afford additional support to the flywheel at one end and the take-off drive at the other.



Close checking of adjustments made no apparent difference, and careful cleaning of bearings and shaft exposed no mechanical difficulty that could account for the trouble. Finally, in an effort to determine the cause of the heating, the chief engineer set up an oil cup on a bracket outside a unit so that its drip would pass down a tube similar to the one inside the crankcase which normally conducted the lubricant to the shaft.

By simply watching the drops as they struck the shaft, a hint was obtained. It was some ten inches from lubricator sight feed to the shaft and the oil droplet, even though falling through the tube "T" of the sketch, struck the shaft with considerable force. In fact, so much force that fully 80 percent of the oil was either spattered into flying spray and lost, or thrown off by centrifugal force as it

struck the thin film of air revolving with the shaft.

At times this air film would tend to bank up within the tube "T", building air pressure enough to check the flow of oil from the sight feed, and holding it there until the glass would fill and shut off all flow.

Having determined the cause, a remedy was sought, and found in an ingenious device to replace the tube "T". By taking a brass plug, "P" in the sketch, threaded to fit in place of the original tube, and drilling a quarter-inch hole through it and sweating a length of copper tubing into the hole, a sickle-shaped oil lead was formed, as shown in the sketch at "R". When this was sprung to clear the shaft and the plug screwed home, the bottom of the copper tube was set to point in the direction of shaft rotation and adjusted to clear the shaft by about 0.010-inch, though if the soft metal had chanced to touch the steel the rotating member would promptly have cut clearance for itself without damage.

With such a curved tube in place of the straight pipe formerly used, oil would run down the inside of the curve, and be wiped from the lip at the bottom by the shaft with no spatter loss. It also developed, after the experimental tube was installed, that the oil lead tending to contact the rotating shaft tangentially instead of radially set up a slight suction within the tubing, so that a steady oil feed could be maintained with less opening of the needle valve in the lubricator than when the original set-up was in use.

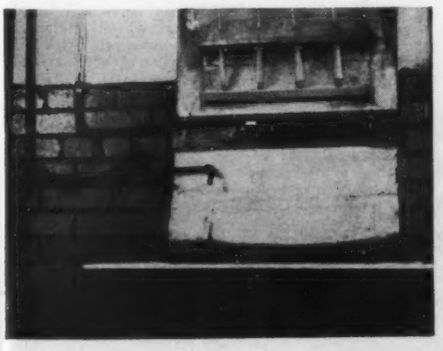
So marked was the difference between the trial bearing so equipped and the others that a complete set of new oil leads was made and installed as the engine units were shut down, since when there has been no trouble with the end bearings.

ELTON STERRETT,
Longview, Texas.

Sample Cocks for Pipe Still

AT the pipe still unit in the plant of Canfield Oil Company at Coraopolis, Pennsylvania, the operator, controlling the action of the plant from the board in the second floor of the pump room, was compelled to run up and down the steps to obtain samples of the several streams coming from the fractionating column.

To save these steps, R. W. Helm, superintendent, placed a sample board in the control room. The sample lines are eighth-inch copper tubing, which



does not hold a large amount of liquid, and by opening the cocks above the sink, only a small volume is drawn out before a working sample is obtained. A hydrometer board was placed above the sink, each hole containing the proper instrument.

As often as necessary, the operator on duty can get gravity of the four most important streams, and when it has been obtained, the beaker of liquid is poured in the sink, which in turn empties into a drain line leading to the slop tank. —J. C. A.

Aligning Pulleys of Different Width

IT is easy for the average mechanic to align pulleys of the same width. An ordinary cord will do it, as illustrated in this sketch. Light "touching contact" of the rim edges of both pulleys is all that is necessary.

But where the pulleys are not of the same width a little calculation is necessary. First align them in precisely the same way and make a mark on the shaft of the smaller pulley to indicate its position and move that pulley in a direction away from the cord.

The distance to move the smaller pulley is obtained from this rule: Subtract the width of the smaller pulley, in inches, from the width of the larger pulley, in inches, and divide the difference by two. The quotient will be the distance, in inches, to move the smaller pulley from the mark made on the shaft. The two pulleys will be aligned perfectly.

For those who prefer formulas to rules, this is the formula:

$$D = \frac{L - S}{2}$$

Where:
D = distance in inches to move the small pulley;
L = width of large pulley in inches;
S = width of small pulley in inches.

Example: If the pulleys are 7 and 4 inches wide, respectively, the above rule and formula tell us that the smaller pulley must be moved 1.5 inches. $(7 - 4) \div 2 = 1.5$ inches.

W. F. SCHAPHORST,
45 Academy St., Newark, N. J.

Boiling Point Apparatus

"AN Apparatus for Measuring the Boiling Points of Lubricating Oils and Other Compounds of High Molecular Weight at Reduced Pressures" is the title of Research Paper RP-796, United States Department of Commerce, National Bureau of Standards. This part is part of Journal of Research of the National Bureau of Standards, Volume 14, June, 1935. The technical bulletin was written by Sylvester T. Schicktanz, research associate at the National Bureau of Standards representing the American Petroleum Institute. The work is part of research Project 6—The Separation, Identification and Determination of the Constituents of Petroleum. Contents include introductory discussion, description of the apparatus (illustrated), experimental procedure and experimental results.

ALL FEED WATERS are the Same to

SAND BANUM

"The Entirely Different Boiler and Engine Treatment"

No matter how chemically different your feed water may be Sand-Banum treats it all the same! Sand-Banum **does not** have a "chemical" action. It simply prevents scale and corrosion formation by holding the "water impurities" in colloidal suspension thereby making it impossible for them to crystallize.

If scale and corrosion are already present, this pure colloidal concentrate penetrates the minute openings of the formation causing it to disintegrate and pass out of the boiler, or internal combustion engine, in the form of sludge.

This is why Sand-Banum is regarded by many as the SAFEST . . . SUREST and SIMPLEST method known to modern science.

MAY WE PROVE IT TO YOU on our "Satisfaction or No Money" Guarantee?

American Sand-Banum Company, Inc.
342 Madison Ave., New York City
Stocks carried by
WESTERN SAND-BANUM COMPANY
Houston, Tex. Denver, Col. Fresno, Cal. and at other convenient points.

CE-CO HI-DEGREE COATING

Where other paints encounter high temperatures and burn off, CECO Hi-degree Coating adheres, providing a durable protection to steel and iron. Also, it retains its good appearance.

Leading oil and gas companies use it to protect hot metal surfaces. You, too, could use it to advantage. Try some and find out.

CHEESMAN-ELLIOT CO., Inc.
Established 1876
Technical Paint Makers
641 Kent Ave., Brooklyn, N. Y.

The CECO line includes effective, protective and decorative paints for every purpose. Write us about your needs.

SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

REFINER AND NATURAL GASOLINE MANUFACTURER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by tile, by abstract, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical Data

The Instantaneous and Mean Specific Heats of Technically Important Gases. H. BRUCKNER. *Gas-u. Wasserfach* **78** (1935) pp. 637-9.

Justi has critically reviewed the methods for determining the specific heat of the more important diatomic gases (H_2 N, CO and O_2) as well as CO_2 and H_2O. In conjunction with the Gas Institute he has selected the best values for these specific heats. These values are presented in tabular form per mol. and per cu. m.; also values for the gases ammonia, hydrogen sulphide, methane, ethane, ethylene and benzene. Mean specific heats per cu. m. are also given over the range of temperature from 0 to 600°C.

The Mean Specific Heat of Gases. W. GUMZ. *Feuerungstech.* **23** (1935) pp. 85-86.

Tables are given presenting the mean specific heat at constant pressure for carbon dioxide, sulphur dioxide, water, nitrogen, oxygen, air, argon, carbon monoxide, hydrogen and methane. Data are based upon spectroscopic procedures. The temperature range covered is 0° to 3500°C.

A Wide Range Boiling-Point Conversion Chart for Hydrocarbons and Petroleum Products. E. S. L. BEALE & P. DOCKSEY. *Jour. Inst. Pet. Tech.* **21** (1935) pp. 860-70.

This is an important paper dealing with the conversion of boiling points of hydrocarbons and petroleum products at different pressures. The authors note that although the vapor pressures of petroleum products have been the subject of several papers in the literature, it is noticeable that the amount of experimental work has been small, and has been largely confined to materials of low boiling point. The experimental work described in this paper forms part of a general study of the Pressure-Volume-Temperature relations of pure hydrocarbons, mixtures, and petroleum products up to the critical point. However, the present paper is concerned mainly with pressures of one atmosphere and lower. The apparatus and methods used are described. At high temperatures allowance was made for cracking by taking the time-temperature curve while heating to the boiling point, and then while the boiling continued for a definite period. A boiling-point chart has been prepared covering the range of boiling point at atmospheric pressure from 100 to 700°C., and from a pressure of 0.01 mm. to 760 mm.

Heats of Vaporization of Eight Gasolines. R. S. JESSUP. *Jour. Research Natl. Bureau of Standards* **15** (1935) pp. 227-36.

The heat of vaporization of eight gasolines was determined. These included one natural and two aviation gasolines, a straight-run and three cracked gasolines, and a "safety fuel", which is a product of hydrogenation and probably contains more aromatic hydrocarbons than the other gasolines. The apparatus used is described. The heat of vaporization of the natural gasoline was 350 international joules per gram, of the two aviation gasolines 350 and 352, of the straight-run naphtha 337, of the cracked naphthas 317, 326 and 331.5, and of the safety fuel 373.

The Variation of the Viscosity of Gases with Temperature Over a Large Temperature Range. A. B. VAN CLEAVE AND O. MAASS. *Canadian Jour. Research* **13** (1935) pp. 140-148.

The viscosity of gases was systematically investigated in the chemical laboratories at McGill University. The apparatus used was based on the principle of damped oscillations. It is claimed that the data for ammonia, propylene, ethylene, and methyl ether are the most accurate secured to date for the viscosity of gases at low temperatures. The variation of viscosity with temperature is expressed by the equation.

$$\text{Log}\ \frac{\eta}{\sqrt{T}} = aT + b$$

in the temperature range 20° to —80°C. Within these temperature limits the viscosity curve is convex to the temperature axis. At higher temperatures it is concave. The authors note that there is a rough parallelism between the inversion temperature of the temperature viscosity curve, the dipole movement, and the critical temperature of the gases.

Physido-chemical Measurements in the (Petroleum) Oil Industry. The Dielectric Constant. R. BULL. *Oel u. Kohle* **11** (1935) pp. 499-503.

The dielectric constant of pure hydrocarbons increases with length of the chain and also with ring-closure. For petroleum distillates, the dielectric constant increases with boiling point. The measurement of the dielectric constant can be applied usefully to determine the composition of hydrocarbon fractions, and also in connection with process work of various kinds.

Chemical Compositions and Reactions

Present Status of Isolation and Identification of the Volatile Hydrocarbons in a Mid-Continent Petroleum. R. T. LESLIE AND J. D. WHITE. *Jour, Research Natl. Bureau of Standards* **15** (1935) pp. 211-26.

The article is a report on the present status of Project 6 of the A.P.I. research on the components of Mid-Continent petroleum. The oil examined was from well No. 6 of the South Ponca field, Oklahoma. It was anticipated that only a few of the lowest-boiling hydrocarbons such as the hexanes could be separated by distillation. Groups of hydrocarbons having the same or almost the same boiling point would form a second kind of constant-boiling fraction, called the "true-solution type." A third class of constant-boiling fractions is the azeotropic mixture, with minimum or maximum boiling point. From the 55 to 145° fraction of the crude, the following hydrocarbons were separated: (1) the normal paraffins hexane, heptane, and octane; (2) the 2-methyl derivatives of these normal paraffins; (3) two other isomers of hexane, 2,3-dimethyl butane and 3-methylpentane; (4) methylcyclopentane and -hexane; (5) the aromatic hydrocarbons benzene, toluene, ethylbenzene, and the three xylenes. The only fraction regarded as a substantially pure single hydrocarbon was that boiling between 89 and 91°, which was 1,1-dimethylcyclopentane. All of the others were mixtures of paraffinic and naphthenic hydrocarbons. Of the entire fraction between 55 and 145°C., 33 percent was paraffins, 7.5 percent cyclopentane, 8.5 cyclohexane, 1 percent cycloheptane, 0.6 percent benzene, 2.2 percent toluene, 2.5 percent ethyl and dimethyl derivatives. A total of 47 hydrocarbons out of the 88 that are known to boil between 55 and 145°C. were isolated. Only 5 hydrocarbons have so far been isolated from the distillate between 145 and 180°C. These are n-nonane, n-decane, and the three trimethyl-benzenes. Various new methods of separation have been developed, and will be developed, to reduce the difficulty of analyzing the naphtha fraction, and which should make it possible to produce the chemical individuals from petroleum on a manufacturing scale.

Cyclic Constituents of Petroleum Ceresin. J. MULLER AND S. PILAT. *Jour. Inst. Pet. Tech.* **21** (1935) pp. 887-94.

While studying an analytical method for the determination of paraffin in asphalt, the authors observed that the paraffins precipitated from asphalt solely by means of solvents did not have a constitution corresponding to the formula C_nH_{2n+2}, but more nearly corresponding to the formula C_nH_{2n-2}. The iodine number of these products was about 6, and it was therefore assumed that the substances consisted chiefly of the hydrocarbons of cyclic constitution. The experiments designed to study this matter are described, and the data secured indicate that it is probable that the paraffins precipitated from asphalt consist chiefly of polymethylene rings. Ozokerite was also studied and found to be of purely aliphatic nature. Tabular data are given on the properties of the high molecular weight aliphatic and naphthene hydrocarbons.

Aromatization by Catalysis of Fractions of Bakou (Surakhany) Gasoline. N. D. ZELINSKY & N. I. SHUYKIN. *Ind. Eng. Chem.* **27** (1935) pp. 1209-11.

The petroleum of Surakhany is rich in naphthenic hydrocarbons, among which those of particular interest are the compounds with six-carbon rings. When these hydrocarbons are dehydrogenated catalytically, aromatic hydrocarbons are formed by the regular splitting off of six hydrogen atoms. Thus, the aromatic substances used extensively as raw materials in various branches of the chemical industry can be made available. The authors found that fractions of Surakhany gasoline could be catalytically dehydrogenated in the presence of nickel deposited on alumina to yield condensate containing about 53 percent (by volume) of aromatic hydrocarbon. Approximately 70 percent of the hydroaromatic hydrocarbons were dehydrogenated after a single passage of the gasoline vapors over the catalyst at 300°C. Simple methods for the regeneration of the spent nickel

. . . in FRANCE

during 1935 a major oil company's second refinery will commence operation of a cracking unit under a Gasoline Products Company license

LICENSES granted under United States and Foreign Patents for: Cross • de Florez • Holmes-Manley • Tube and Tank Cracking Processes and Combination Cracking Units.

Licensing Agents:
The M. W. KELLOGG CO.
225 Broadway · New York
or its
European Representative:
Compagnie Technique des Petroles · 134 Boulevard Haussmann · Paris, France

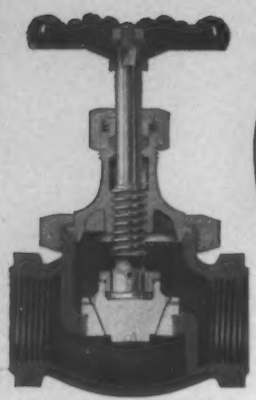
• A constantly increasing number of refiners recognize the practical economic advantages of an association with a licensing organization whose service is comprehensive enough to meet changing economic conditions. Gasoline Products Company has achieved worldwide recognition through applying to refiners' problems the principles of integrated and progressive developments, together with the option to commute royalties for any desired annual gasoline capacity.

• By coordinating its own developments with those of other major refining organizations, Gasoline Products Company is in a position to furnish combination cracking units incorporating the latest designs, methods and equipment. These combination cracking units enable the refiner to meet his individual requirements under a license permitting a maximum of operating freedom.

GASOLINE PRODUCTS COMPANY

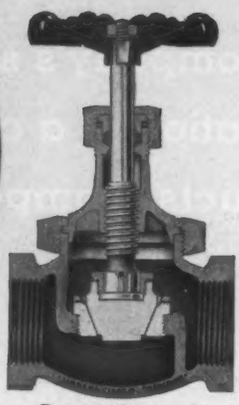
INCORPORATED

11 COMMERCE STREET · NEWARK, NEW JERSEY



Iron Body "Ferrenewo"
Fig. 1021-P, 150 lb. SP

NS5
SEATS AND DISCS
PATENTED



Bronze "Renewo"
Fig. 73-P, 200 lb. SP
Fig. 16-P, 300 lb. SP

LUNKENHEIMER

PLUG TYPE

"FERRENEWO" and "RENEWO" VALVES

for Throttling, Drain, Drip, Water Column Blow Down and other Severe Service—also preferred by some users for General Service

"NS5" Alloy (patented in U. S.) the material of which Plug Type Seats and Discs are made is a new and exclusive development—the result of exhaustive research in the Lunkenheimer laboratories. It is a non-ferrous composition of uniformly great hardness (300 Brinell) and retains its hardness at high temperatures. "NS5" will not gall; it is resistant to wear, abrasion, erosion and corrosion.

The plug type disc is deep-seated and ground into its own seat, to a uniform bearing from end to end. Each plug is properly tapered with long bearing contact to fit snugly into its seat—just like a cork in a bottle—providing a fit as perfect as can be made to insure a tight seat and satisfactory service.

Most valve users have troublesome throttling, drain, drip, water column blow down and other severe service which play havoc with seats and discs. With the combination of correct design and "NS5" seating material, Plug Type Valves approximate as closely as possible a satisfactory solution to these problems.

The interchangeability of parts between Plug Type and Full-Way "Renewo" and "Ferrenewo" Valves is explained in the new booklet F 541. May we send you a copy?

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO BOSTON
PHILADELPHIA SAN FRANCISCO
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

BOILER MOUNTINGS — LUNKENHEIMER VALVES — LUBRICATING DEVICES

102-71PB-89

catalyst have been devised. Two passages of the gasoline vapor over platinum (deposited on activated charcoal) were sufficient almost completely to dehydrogenate the hydroaromatic hydrocarbons at 300°C. Two methods for the determination of aromatic hydrocarbons in mixture with naphthenic and paraffinic hydrocarbons are described. It was proved that the result of the sulfuric acid method and the aniline critical solution temperature method are substantially the same.

The Cracking of Hydrocarbons and Petroleum. E. TERRES, C. WALTHER, H. SCHMIDT, J. POMERANIEC & O. FOCSANER. *Oel u. Kohle* **2** (1934) pp. 2-6 and 53-6

In order to have a better understanding of the cracking of hydrocarbons and petroleum oils the thermal decomposition of the typical paraffins (hexane, nonane, hexadecane) and of the hydrogenated aromatics (cyclohexane, decalin) was studied. The conditions of the experiment were such that length of reaction time could be regulated. It was noted that when steam was passed through the tubes with hexane the deposition of carbon and viscous tar was avoided. Equations are given for decompositions of the various hydrocarbons. The hydro-aromatic hydrocarbons are first progressively dehydrogenated. Benzene is formed from cyclohexane. Tetrahydrobenzene decomposes in another manner to yield butadiene and ethylene. The formation of a 5-carbon ring from a disrupted 6-carbon ring can result from the fact that 2 methyl groups are so arranged that a dimethylcyclopentane is formed. Under canditions of energetic decomposition free radicals exist that polymerize and condense to form homologs of naphthalene.

Perhydrochrysene (Octadecahydrochrysene, $C_{18}H_{30}$) and the Constitution of Lubricating Oils. A. SPILKER. *Angew. Chem.* **48** (1935) pp. 368-9.

By the use of reagents free from sulphur it was possible to prepare $C_{18}H_{30}$ from chrysene by hydrogenation using a nickel catalyst and decalin as solvent. This substance is a water-white, highly viscous oil that does not crystallize at —20°C. It can be distilled at ordinary pressure without serious decomposition. The properties are given. The oil does not react with such oxidizing agents as bromine or permanganate. Long shaking with concentrated sulphuric acid results in only a light yellow color. The author discusses the constitution of lubricating oils. He believes that the requirements of good lubricating substances are a close-spaced structure and a high hydrogen content.

Syntheses from Natural Gas Hydrocarbons. H. B. HASS, E. T. MCBEE & P. WEBER, *Ind. Eng. Chem.* **27** (1935) pp. 1190-95.

The authors state that most of the articles appearing in chemical literature on the chlorination of the paraffins of three to five carbon atoms contain serious errors. They state that little published work in this field is reliable as regards the fundamental questions of identity of products and ratios of isomers. Also, the literature abounds in incorrect physical constants and false identifications. Work has been carried on continuously in the Purdue laboratories since 1929, and has yielded results that are now regarded as reasonably complete and mutually consistent. The chlorination of the simpler paraffins is important, since these substances are now serving as raw materials for the commercial production of amyl alcohols, acetates, xanthates, sulfides and mercaptans, for tert-amyl-phenol-formaldehyde resins, caproic acid, and many other organic chemicals. The authors state that in no case have they found evidence of a carbon skeleton rearrangement during thermal or photochemical chlorinations. In every instance all of the theoretically possible isomeric monochloride obtainable without such rearrangement have been found. These generalizations extend to the polychlorides, although in this regard their work is not complete. Many data are given, methods of procedure and apparatus are described, and a bibliography of thirty-two references is appended.

The Chlorination of Propane. I. The Homogeneous Reaction. S. YUSTER AND L. H. REYERSON. *J. Phys. Chem.* **39** (1935) pp. 859-75.

The homogeneous reaction of propane and chlorine was shown to be of the chain type, as evidenced by the inhibitory effect of oxygen, the existence of an induction period, and reduction in velocity by packing and explosions. Reaction chains are both started and stopped by the wall; high partial pressures of chlorine poison the wall. The heat of activation, calculated by means of the temperature coefficient

In just a few short years . . . . . .

A small enclosed kettle over a masonry furnace. A pipe to condense the gasoline vapors. A spring to supply the cooling water. And from this simple oil refining equipment has sprung, in just a few short years, one of the world's largest industries. • The progress of the refining industry has paralleled the development of steels—steels to combat corrosion, steels to stand up under tremendous pressures, steels to withstand high temperatures. And among those steels capable of meeting the severe conditions of modern refinery service, none stands higher than ENDURO, Republic's Perfected Stainless and Heat-Resisting Steel. • ENDURO is available in a wide range of alloy combinations, permitting a selection of the grade most economical for the service in which it is to be used. These types cover an operating temperature range from 1100° to above 2100°. All are far superior to and more economical than ordinary steel for still tubes, condenser tubes, heat transfer units, hot oil and vapor lines, bubble caps, trays, plates, tube supports, hangers and valve and pump parts. • Republic metallurgists will gladly make recommendations if you will outline your requirements.

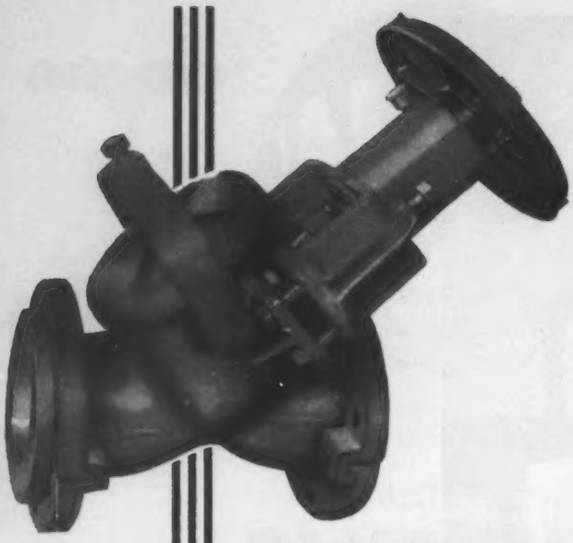
Republic Steel
CORPORATION

GENERAL OFFICES · · · YOUNGSTOWN, OHIO
ALLOY STEEL DIVISION · · · MASSILLON, OHIO

REPUBLIC STEEL

ENDURO
REPUBLIC'S PERFECTED STAINLESS AND HEAT-RESISTING STEELS

Licensed under Chemical Foundation Patents Nos. 1316817 and 1339378.



ACID VALVES

Developed for the chemical industry by a company which for years has been familiar with the moving of processed liquids, LaBour Chemical Valves have amply demonstrated their stamina and the economy of their use. The increasing use of various acids in refining processes places greater and greater importance upon the selection of the handling equipment. LaBour Valves for use with acid are a safe choice.

Standard materials used in LaBour Chemical Valves are suitable for most of the acids outside the chlorine group, and practically all caustics. To meet special conditions, valves of the LaBour construction can be furnished in various alloys and combinations.

LaBour engineers will be glad to help you with your problems in controlling the flow of acid. There is no cost or obligation when you submit your problems to them.

ORIGINATORS OF THE SELF-PRIMING CENTRIFUGAL PUMP

THE LABOUR COMPANY, Inc.
807 STERLING AVENUE
ELKHART, INDIANA

TUBE CLEANER *FOR* CONDENSERS, HEAT EXCHANGERS FEED WATER HEATERS

OUTSTANDING FEATURES—
1. Automatic Expanding Type.
2. Removable Plates.
3. Hand Operated.
4. Efficiency and Durability Combined.
5. NOTHING TO LOSE, ALL TO GAIN.

Every large and small plant needs this fine tool, made in the following sizes: ¾" ⅞" 1" 1¼" 1½" 2" 2½" 3" 3½" 4" This Cleaner is now used by many outstanding plants with maximum efficiency and minimum cost. **Why not let us send you a tool on Test Approval? If not satisfactory, return it to us without obligation.**

AUTOMATIC TUBE CLEANER CO. **405 Penn Ave. Pittsburgh, Pa.**
Also manufacturers of Sanitary and Boiler Tube Cleaners, Ice Can Retainers, Shot Gun Cleaner

and by collision efficiency, is approximately 20,000 calories per mol.

The Explosion of Mixtures of Combustible Gases with Air, by Nuclear Drops of Water and other Nuclei and by X-Rays. Part V. R. O. KING & G. MOLE. *Jour. Inst. Pet. Tech.* **21** (1935) pp. 838-59.

The paper is a report of the continuation of studies of the ignition of H_2-air mixtures. These studies confirm the view previously stated that self-ignition temperature rises as surface activity increases. The ignition of the gas mixture does not arise on the surface, but occurs in the layer of gas adjacent to the hot surface, described conveniently as the boundary layer. Ignition does not occur in the purely gaseous phase or central stream of gas in the tube, because if steam is formed at the surface at a suitable rate, the central stream cannot be ignited by any temperature attainable by heating the tube. The results are of interest in connection with current theories of ignition and explosion, but their detailed application to the elucidation of these problems is postponed until further experiments have been carried on. Experiments are also described on the ignition of ethylene-air mixtures, and on the effect of a variety of nuclei, mainly mineral dusts, on the ignition and explosion of a mixture of hydrogen and air; the exceptional efficacy of Ni_2O_3-dust in the ignition of mixtures of air with hydrogen, ethylene or methane, is described.

Manufacture: Processes and Plant

Evaluation of Liquid-Liquid Heat Exchangers. T. W. EVANS. *Ind. Eng. Chem.* **27** (1935) pp. 1212-15.

In considering the performance of countercurrent heat exchangers it is possible to introduce the concept of a perfect or ideal heat exchanger. By so doing the performance of a given exchanger may be evaluated and visualized as the equivalent of some number of ideal units. This number is directly proportional to the total heat transmitting surface and to the heat transfer coefficient. The author develops the mathematical expressions and illustrates their use for two cases, one involving the counter flow of two liquids in the heat exchanger, and the other calculation of the maximum temperature change that can occur when a fixed quantity of one material is heated or cooled by successive small quantities of a second material, for example, the cooling of an autoclave by circulating water through a coil inside the kettle.

How to Use Pilot Plants in Process Development. F. C. VILBRANDT. *Chem. & Met. Eng.* **42** (1935) pp. 554-5.

Pilot plant operation is a phase of engineering experimental procedure introduced into the development of American chemical industry with the rise of the chemical engineering profession. The application of research in pilot plant procedure to a typical problem involving the oxidation of butane to alcohols, aldehydes and acids is described. The value of the pilot plant procedure is well illustrated.

Kinetics of the Vapor Phase Cracking of Petroleum Products. A. I. DINTZES, M. P. ESHEVSKAYA AND TZ. I. KLABINA *Khim Tverd. Topliva* **6** (1935) pp. 428-38.

In a very superficial (10-15%) decomposition the velocity of the cracking reaction is practically independent of the degree of cracking or of the duration of the reaction, and it is in satisfactory agreement with the law of molecular reactions. Individual narrow cuts of straight-run petroleum of Grozny and Baku origin b. at 100-270°C. are characterized by practically identical energy of activation of the cracking reaction which amounts to 50,000 ± 4000 cal. per g.M. The composition of the cracked products depends but little on the reaction temperature within 500-600°C., while the amount of unsaturates increases slightly when exceeding this temperature. The statement by Pease (C. A. 27, 4992) on the drop of the activation energy with the increase in hydrocarbon molecules, is contradicted. Another statement by Pease, namely that the ratio of the energy of activation to the log A of the Arrhenius equation $K = A.e^{-E/RT}$ is a constant, is also questioned.

Abs. by For. Pet. Tech.

Progress in the Production of Paraffins. R. FUSSTEIG. *Petroleum Z.* **31** (1935) pp. 1-4; cf. C. A. 28 5643[8].

The author comments on the fact that recent observations have shown that paraffin occurs

A Gasoline Marketer Writes:

We are buying our anti-knock gasoline from refineries who are using Dubbs cracking process We find this fuel very satisfactory Have you any information available that we may use in our advertising to convince our customers of the value of this fuel which we sell under our own brand? —TONY'S GAS HOUSE, MCALESTER, OKLA, JAY J BASOLO, MANAGER

Tell them the truth, Mr. Basolo, and here is the truth:

Dubbscracked gasoline gives more miles per gallon than ordinary gasoline —and without knocking—because it IS Dubbscracked

That story will bring motorists into your stations to find out—and the Dubbscracked gasoline itself will keep bringing them back

AND THIS STORY IS JUST AS IMPORTANT TO YOU AS IT IS TO MR. BASOLO

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

THE FARMER
The oldest occupation in the world is the foundation of modern existence.

From The Farmer we learn that land becomes impoverished, non-productive when we take from the soil and put nothing back. Even Mother Earth demands proper maintenance.

No different is industry. The ability to turn out a better and more lasting product is only the first payment on the price of success. Maintaining products after they are sold is essential to growth and progress.

Key Refinery Fittings are the finest that good materials and perfect workmanship can produce. This much is taken for granted. But what is equally important is the "Service after the Sale" that the Key Company is equipped to offer — a service that is as faultless as the fittings and that extends immeasurably the useful life of the fittings.

Key Re-conditioning Service is entrusted only to skilled mechanics who have served a long apprenticeship in our organization. The service is usually performed in the refinery yard without removing the fittings from the tubes, thus prolonging tube and fitting life.

Key Fittings are in service throughout the world. Hence, Key Re-conditioning Service is available to any refinery anywhere at a contract rate which will be quoted on request.

KEY COMPANY

EAST SAINT LOUIS, ILLINOIS
NEW YORK CITY TOLEDO TULSA DALLAS HOUSTON
LOS ANGELES SAN FRANCISCO

Pioneers lead the way to prosperity

Cracking Units produce high-quality distillates most economically, efficiently and safely when lime, of the proper quality, is added to the charging stock entering the still. Our 24-page booklet "Pioneer Lime—A Contribution to Oil Refining Efficiency" explains how lime functions to prevent corrosion; facilitate coke removal, and promote "B. S." separation, and why **Pioneer Oyster-Shell Lime** is especially adapted to these operations. A copy is yours on request.

THE HADEN LIME COMPANY
MFRS. OF PIONEER OYSTER SHELL LIME
1720 SHEPHERD STREET
HOUSTON-TEXAS

only in a crystalline condition. The so-called amorphous form arose as a result of the influence of other components in the solution. The separation of paraffins through distillation for the removal of the asphaltic substances is discussed. However, purification by distillation is not enough because some of the paraffin-containing fractions are too viscous for proper crystallization. This can be obviated by dilution. The needle-form of paraffin is most desirable because it expedites filtration. Refining with sulphuric acid is helpful, because it removes impurities that interfere with crystallization. The more efficacious procedure is treatment with a 1-10% alcoholic phenol solution, which removes the adsorbed coating of substances that interfere with the needle crystals formed. Types of coolers and crystallizer are discussed, and a new type of crystallizer consisting of two concentric tubes is described. Tests that have been made show that the new type of cooler increases the yield of paraffin, and that the sweating properties of the wax secured are superior.

Asphalt from Paraffinic Mazout. C. LEU. *Moniteur du Petrole Roumain* **June 15** (1935) pp. 865-6.

The author refutes the belief that good road asphalts cannot be made from paraffinic petroleums or mazouts. This belief was affirmed by the works of Marcusson, who considers that asphalts of this type do not have the necessary elasticity, and rapidly become friable. Richardson is also positive in his statement in this regard. However, the Polish technologists Haussmann, Burstyn, and Piotrowsky, have been able gradually to prove the falsity of this prejudice. Haussmann has produced a whole series of excellent road asphalts on an industrial scale. American standards say nothing regarding the content of paraffins; however, German standards are exacting in this connection.

The Coking of Petroleum Residues, D. G. JONES. *Jour. Inst. Pet. Tech.* **21** (1935) pp. 895-906.

The author notes the desirability of removing the high carbon containing components of heavy oil residues through coking so that the lighter fractions can be further cracked for motor fuel production. He notes the importance of hydrogenation, and states that this is a process for larger companies, and not for a small refinery. Various coking procedures that have been used are described, after which the evolution of the novel method of coking petroleum residues is outlined. In a typical run the coke was 6 percent by weight, gas 19 percent by weight, and distillate 75 percent by weight. The coking apparatus was continuous in operation. The rates of heat transfer are given, and various comments on matters of design. In a later paper the operation of the full-scale plant is to be described, giving details of throughputs, yields, and types of products. Residual fuel from Comodoro Rivadavia crude was run.

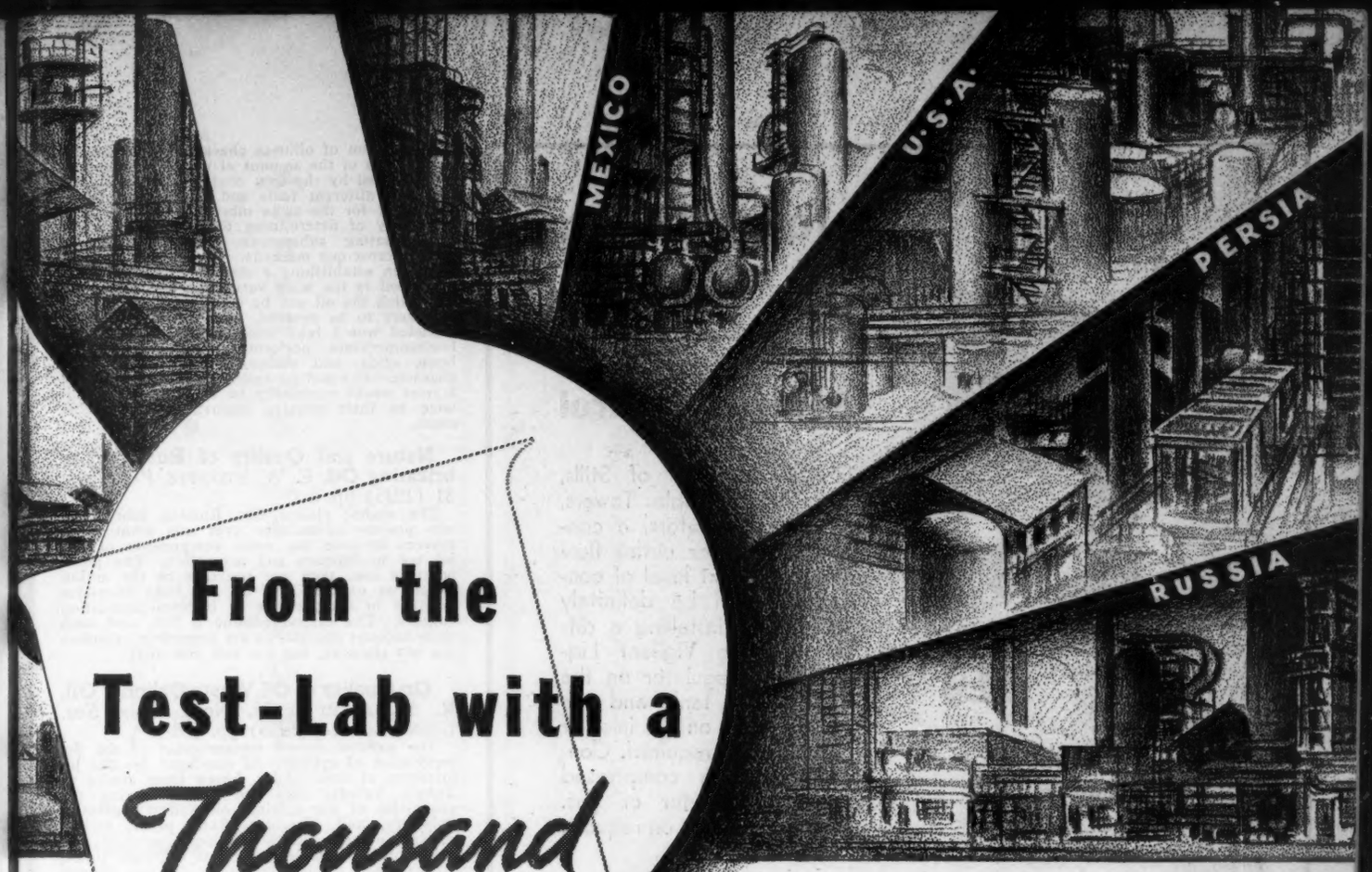
The Production of Hydrocarbon Oils from Industrial Gases. Part I. A. AICHER, W. W. MYDDLETON & J. WALKER. *Jour. Soc. Chem. Ind.* **54** (1935) pp. 313T-20T.

The paper is the first of a series devoted to the production of oils from carbon monoxide and hydrogen. It is particularly concerned with studies of a new form of catalyst. The purification of the gases used is described, the reaction is followed stage by stage, and the distribution of heat of reaction along a catalyst vessel is followed to permit adequate control of catalyst temperature at all points. A method for determining a "time of contact" factor in flow reactions has been devised. The influence of the adsorption of oil on the catalyst surface was determined, and an explanation is given of the gradual waxing of the catalyst, with the consequent loss of activity.

Products: Properties and Utilization

Performance Tests of Lubricating Oils in Automobile Engines, H. A. EVERETT AND F. C. STEWART. *Penna. State Coll. Eng. Expt. Sta. Ser., Bull* **44** (1935) 52 pp.

The bulletin describes work done over a period of approximately two years at Penna. State in the testing of lubricating oils in four automobile engines purchased and fitted for the purpose, and operated in the laboratory in connection with dynamometers. The testing technic is described, and the voluminous data secured from the testing of seven different oils are presented. Collateral studies included the



From the Test-Lab with a *Thousand Branches*

WHEREVER oil is produced or refined, Chapman Valves are undergoing the only test that Chapman engineers accept as final . . . the endless test of *actual service.*

In their laboratories in Indian Orchard, Chapman metallurgists develop a better design, a better alloy, a better manufacturing method. They test it. Then they give it to critical oil engineers and get *them* to test it *under field conditions.* Not until the new development has proved itself over and over—under all kinds of operating conditions—is it released to the industry.

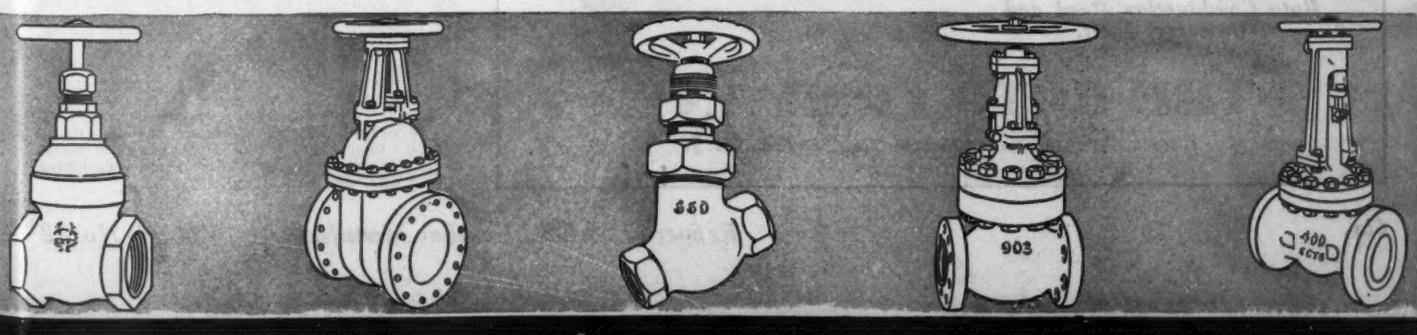
Choose from the Chapman line, and you choose valves that have *proved* their resistance to corrosion and wear in a laboratory that reaches clear 'round the world—a lab with "branches" in every country that produces or refines oil.

For low maintenance costs . . . specify Chapman Valves. The line is complete: gate, globe and check valves and fittings in all sizes for pressures up to 1500 pounds and temperatures from 50° below zero to 1000° F. Write for bulletins.

CHAPMAN CHROME TUNGSTEN STEEL—the "tough-hard" alloy that thrives on severe corrosive conditions and shows an actual improvement in grain structures after long service at temperatures of 1000° F. and pressures of 1500 pounds—is one of the results of the close co-operation of Chapman and oil industry engineers. When last reported, a set of Chapman Chrome Tungsten Steel Valves were finishing their fourth year on a cracking process that had been destroying ordinary valves in a few weeks.

The CHAPMAN VALVE MANUFACTURING COMPANY

INDIAN ORCHARD, MASSACHUSETTS



VIGILANT
Liquid-Level
REGULATOR

LIQUID LEVEL
and
Flow In or Out
under positive
Remote Control

In the operation of Stills, Vaporizers, Bubble Towers, and Dephlegmators, a continuous inlet or outlet flow and a constant level of condensates can be definitely secured by installing a differential-type Vigilant Liquid Level Regulator on the side of the tank, and the control valve on the inlet or outlet line as required. Control works on compressed air, steam, water or gas. Bulletin No. 3113 on request.

THE CHAPLIN-FULTON MANUFACTURING CO.
28-40 Penn Avenue Pittsburgh, Pa.

ROTO TUBE CLEANERS
built for **Oil Still Tubes, 3" I.D.** *and up*

Roto Special 6-way Drill Head and Universal Joint.

Roto Air Driven Cleaner with Swing Frame Head attached.

Roto Combination Head and Universal Joint.

THE ROTO COMPANY
Sussex Avenue and Newark St., Newark, N. J.

determination of oiliness characteristics, the determination of the amount of wear in the engine as measured by the iron content of the oil, the effect of different fuels and detonation on engine wear for the same lubricating oil, and the possibility of determining the character of the cantaminating substances by microscopic or photomicroscopic methods. The outstanding difficulty in establishing a standard for appraising motor oil is the wide variety of conditions under which the oil will be used. If a merit number were to be evolved, factors that would be included would take into account the stability, low-temperature performance, cleanness (carbons, acids and sludge), friction, and wear characteristics and consumption of the oil. These factors would necessarily be weighted in accordance to their relative importance in specific cases.

Nature and Quality of Russian Lubricating Oil. E. W. Steinitz. *Petroleum* **31** (1935) pp. 6-7.

The author claims that Russian lubricating oils possess advantages over oils from other sources because the main components of the oil are naphthenes and aromatics. The pour-point is low, they are resistant to the action of air or oxygen, and do not form excessive deposits in compressors or internal-combustion engines. The carbon residue is low, and such carbonaceous deposits as are formed in cylinders are not resinous, but are soft and oily.

On Quality of Oil Waste Cylinder Oil. R. Yamasaki & H. Noro. *Jour. Soc. Chem. Ind.* **54** (1935) pp. 808-9.

The authors record measurement of the deterioration of cylinder oil employed for the lubrication of automobiles driven from Osaka to Tokyo. Tabular data are given showing the properties of the original oil and the gravity, volatility, and viscosity, flash point, carbon residue, percent ash, solidifying point and acid value of the samples taken at different times. Gravity and solidifying points did not change greatly. Lowering of viscosity was proportional to driving distance. Carbon residue, ash content, and acid value increased together as the journey proceeded, and the increment of acid value increase coincided with that of ash content.

Use of Refinery Gas for Cold Enrichment. A. H. Schaaf. *Am. Gas. Assoc., Proc.* (1934) pp. 933-5.

At the plant of the Brooklyn Union Gas Campany a blue water gas of 300 B.t.u. and 0.55 specific gravity is enriched with refinery gas of 1700 B.t.u. and 1.10 gravity. Finished gas has a thermal value of 550 B.t.u. and a gravity of 0.648. The two gases were mixed in the proportion, blue gas 82.2%, and refinery gas 17.8%.

Color Measurements of Oils and Other Liquids. E. R. Bolton and K. A. Williams. *Analyst* **60** (1935) pp. 447-54.

If a photoelectric cell is to be used for the measurement of color, it must be provided that no infra-red rays be allowed to impinge upon the cell. The authors describe an instrument in which Weston Photronic cell (Model 594) is used, in series with a sensitive galvanometer. The infra-red rays from the electric lamp used for illumination are filtered and removed by means of a two-inch cell containing 1% $CuSO_4$. The filters used are three chosen by Guild, namely Wratten filters 71A, 49B and 62. The instrument permits the making of more accurate measurements of color than has hitherto been possible. It is unnecessary accurately to standardize the light source. Readings that are reproducible to within 1 or 2% can be taken by different observers very rapidly. It is noted that the results are comparable with those obtained by the best visual methods.

The Laboratory Testing of Lubricants. F. J. Slee. *Jour. Soc. Chem. Ind.* **54** (1935) pp. 809-14.

The laboratory testing of lubricants may be considered as related to two objectives; first, the re-identification of lubricants already found satisfactory for some specific service; and second, interpretation of laboratory tests to predict results that may be expected in practice. The significance of the common laboratory tests is first considered. Specific gravity cannot be said to represent in any way the lubricating value of an oil, and is useful solely as a means of identification. Flash-point is valuable to insure freedom from contamination with light fractions, and also for purposes of identification. Viscosity is considered the most useful physical test. The selection of lubricants for particular purposes, as for example, line shafting, general machinery, electric motors, steam cylinder oils, steam turbines and enclosed steam engine crank-case oils, and internal-combustion engine oils, are considered.

All applications . one standard of accuracy

Almost invariably the first American Meter Company instrument in a plant is adopted by the engineers for a critical application requiring exceptional accuracy.

Whatever your application in flow measurement and control of gases, steam and liquids, experience commends the fewer working parts and simplicity of design of these instruments for operation where the need is most exacting.

First cost and low operating cost combined make American Meter Company instruments outstandingly economical.

The following new engineering bulletins, just published, give complete up-to-date data on the various phases of orifice and flow measurement and control. Please write for any you have not received: Orifice Meters & Flow Meters: Recording; Integrating; Remote Measurement (EG 2). Flow Meters: Indicating (E3). Liquid Level and Rate-Volume Control; Proportional Control (E5)

AMERICAN METER COMPANY
INCORPORATED
The World's Largest Manufacturers of Gas Meters and Allied Apparatus
ESTABLISHED 1836

METRIC METAL WORKS • ERIE, PENNSYLVANIA

329

New Equipment for the Modern Plant

Welding Machine

THE LINCOLN ELECTRIC COMPANY

The Lincoln Electric Company, Cleveland, Ohio, has announced a new 200-ampere special engine driven "Shield Arc" welder. This new model, known as the "200-ampere Shield Arc Special," supplies a uniform current for welding with bare or heavily coated shielded arc type electrodes in all sizes up to ¼-inch. The welding current range of this new machine is from 60 to 250 amperes. Its generator is the single operator variable voltage type with completely laminated magnetic circuit and equipped with interpoles, and requires no external reactance or stabilizer. The patented Lincoln dual control of welding current is provided adjustment of both series and shunt fields. Separate excitation of the generator shunt fields is supplied by an exciter connected on the generator end of the unit. A generator field rheostat and a current regulating switch are mounted in vertical position on a "dead-front" steel control panel. Electrode and ground cable connections of the wing nut type are also in an easily accessible position.

The welder is powered by a Waukesha four-cylinder engine which delivers 23 H.P. at 1400 R.P.M., the speed at which the welder is operated. A gear driven governor maintains proper engine speed at all load conditions. The engine is equipped with standard high tension magneto and vertical type carburetor with air cleaner.

Tube Caliper

KOALT ENGINEERING COMPANY

Koalt Engineering Company, Tulsa, has perfected a tube caliper that may be drawn through any length still tube and the maximum inside diameter ascertained. It is made in standard sizes from two-inch to five-inch inside diameter. Other sizes may be made to order.

This caliper originally was developed by a mechanic of a large refining company and has been improved and perfected by the Koalt Engineering Company. Tube replacement may be determined by the use of this caliper and thus eliminating tube ruptures from thinned walls. Two hundred 30-foot tubes may be calipered and the records completed by two men in about two hours, according to the manufacturers.

The caliper comes complete with special tapes for pulling through tubes if desired. It may also be used for detecting bulges in straight tube water tube boilers.

Reintjes Boiler Arches

Boiler Arches

GEO. P. REINTJES COMPANY

Geo. P. Reintjes Company, Kansas City, Mo., has adapted its standard wall tiles for use as rear arches on horizontal return tubular boilers. The design is such that each tile is individually hung by an independent casting from a pipe. Infiltration of excess air is prevented by the placing of a standard fire brick between each pair of tiles, yet freedom of expansion and contraction is provided. The advantage of the flat suspended arch is to provide turbulence in the gases so that all of the boiler tubes receive an equal proportion of the hot gases, thereby increasing boiler efficiency.

Scale

THE KRON COMPANY

The Kron Company, Bridgeport, Connecticut, has recently announced a new small bench scale for general utility purposes. The platform is 16½ x 18½ and the capacity ranges from 50 to 125 pounds.

This new unit uses a Junior or smaller size dial mechanism which is similar to the standard Kron double pendulum ball bearing type. This mechanism, like the larger one, is very simple and rugged in design and maintains its accuracy over long periods without adjustment. In the platform the standard Kron full floating type of construction is utilized. This design is such that none of the lateral motion of the platform is transmitted to the lever system. In operation all levers operate about fixed fulcrums. This means pivot and bearing wear only when a load is actually being weighed, and greatly increases the life of the scale.

Conduit Grounding

GENERAL ELECTRIC COMPANY

General Electric Company, Schenectady, New York, announces four new conduit grounding items, one box for fixture mounting and three grounding fittings which can be quickly installed and afford secure connections.

The fixture box, designated as Type SP-5200B, provides a simple and effective method of grounding, and makes possible firm mechanical and electrical connection between the box and the armor.

Two of the fittings, designated as Type SP-825 and SP-826 and intended for ½- and ¾-inch conduit respectively, are equipped with a reversible shackle which fits three sizes of water pipe—a U-bolt with a wide, flat strap being used to make the connection. This affords high bonding pressure without injury to the pipe and allows the conduit hub to meet the pipe at any angle. The Type SP-828 fitting has a connection which firmly grips and holds the armored cable.

For solderless connection of the fittings, the wire is simply hooked into the groove provided and the lug is screwed tight as a bonding washer. For soldered connection, the grounding wire is run into the soldering lug.

Diesel Engines

HERCULES MOTORS CORPORATION

Hercules Motors Corporation, Canton, Ohio, has announced series "DJX" Diesel engines, which enlarges its line of high-speed six-cylinder Diesels paralleling in performance and installation dimensions similar displacement Hercules gasoline engines.

Both models in the new series are six cylinder, the smallest, the "DJXB," having a 3½-inch bore and a 4½-inch stroke, a 260 cubic inch displacement. The "DJXC" has a bore of 3 11/16 inches and a 4½-inch stroke, with a 288 cubic inch displacement. On the dynamometer the "DJXB" is rated 79 horsepower and the "DJXC" 82.5 horsepower at an engine speed of 2600 revolutions per minute.

The manufacturers claim these to be the smallest high-speed heavy-duty Diesels made in America. This "DJX" series are interchangeable from an installation standpoint with the Hercules "JX" series of gasoline engines.

The general design of the "DJX" series follows that developed by Hercules in its two larger Diesels, the "DHXB" and "DRXB" including the patented auxiliary combustion chamber—which assures very complete combustion—controlling also the burning of the fuel, which results in smooth, powerful,

Koalt Tube Caliper

flexible and economical performance. This pre-combustion chamber is located at the side of the cylinder bore, and the "throat" which connects the cylinder with the chamber is so designed that the piston on its approach to top center on the compression stroke gradually reduces the throat area, thus automatically increasing the velocity of air entering this chamber, at the time fuel is injected, insuring very thorough mixing of fuel and air.

A very rigid crankshaft of ample proportions is supported by seven bearings in a crankcase which is cast integral with the cylinders, which crankcase also supports the four bearing camshaft. Aluminum alloy pistons are used for maximum heat conductivity and lightness of reciprocating parts. Connecting rods are of heat treated nickel chrome molybdenum steel, rifle drilled, providing pressure lubrication to the full floating piston pins.

Particular attention has been given to the water jackets and water passages, and a large capacity centrifugal water pump supplies ample cooling water which sweeps the surfaces in contact with high temperatures, this insuring a cool engine. The cooling fan is driven by a "V" belt from a pulley mounted on an extension of the crankshaft.

Lubrication is forced feed, supplied by geared pump, to all main, connecting rod, piston pin bearings, and to the gear train, as well as the overhead valve mechanism. Splash, or throw-off from the connecting rods lubricate the cylinder walls. An oil filter to excess capacity is furnished with the engine to insure clean oil.

A plunger type fuel pump is used, built with a vacuum type governor as an integral part of the pump, and it is mounted on the same side of the engine as the fuel injectors, intake manifold, and air cleaners. On the exhaust manifold side are mounted the lubricating oil filter, water pump, generator and starting motor.

Absolute Pressure Gauge

THE FOXBORO COMPANY

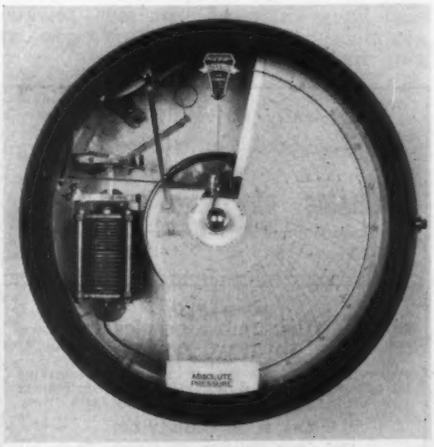
The Foxboro Company, Foxboro, Mass., announces development of a new gauge to measure absolute pressure. This instrument has a unique method of compensating for changes in barometric pressure that assures correct readings at all times.

The pressure measuring and barometric compensation units are mounted together forming a complete, rugged and integral actuating movement. Two hydrons, one measuring direct pressure and the other barometric pressure are so connected that their pressures directly oppose each other. The compensating hydron which is sealed under full vacuum exactly counterbalances the barometric effect on the main pressure hydron, and thus enables that hydron to measure only true absolute pressure.

This method of measuring absolute pressure is comparable with the manometer method of measuring differential pressure, whereas previous methods could be likened to the method of using two pressure gauges for the same purpose, it is said. In the latter case a small error in either the pressure readings amounts to a large percentage of the difference.

New design has enabled this company to do away with all unnecessary linkage from the actuating movement. Lost motion is thus eliminated from the Foxboro absolute pressure instrument.

The gauge is protected against overrange, is light and portable, and contains no liquid to spill or lose its seal. It can be equipped with the Foxboro Stabilog mechanism and used for control.



Foxboro Gauge

Pulleys

THE DAYTON RUBBER MANUFACTURING COMPANY

The Dayton Rubber Manufacturing Company, Dayton, Ohio, has announced a complete new line of "Day-Steel" pulleys of cast-machined (semi-steel) construction, for use in conjunction with the Dayton "Cog-Belt" drive for all ratings up to 15 horsepower.

The new pulleys are so formed as to be of maximum strength with elimination of excess metal, thereby providing cast-machined pulleys of approximately the same weight as the pressed steel pulley. All finished surfaces are machined to accurate limit of precision work, the special semi-steel providing an exceptionally smooth and close grained groove surface. All pulleys are accurately balanced to insure a true-running drive throughout. A high quality finished groove provides protection and gives an outstanding appearance, the manufacturer claims.

The new pulleys and "Cog-Belt" drives are completely described and illustrated in catalog No. 110-C. Also included in this catalog are complete and simplified drive tables which require no engineering or calculations.

Emergency Kit

DAVIS EMERGENCY EQUIPMENT COMPANY

Davis Emergency Equipment Company, New York City, has announced a new type first aid kit to meet the specifications of industrial medical directors. The special feature of this new kit, which is known as "Brac-Kit," is that it can be installed in a given place, yet its contents are constantly available in emergencies and are protected from contamination and damage when treatment is applied.

The kit consists of two baked enamel steel cases, an outer case that can be permanently attached to a wall by means of screws, and an inner case that is normally kept inside the outer, where it is held by a simple lock. The kit contains 10 D-carton first aid units.

Tube Cleaner

THE ROTO COMPANY

The Roto Company, 147 Sussex Avenue, Newark, New Jersey, announces a new and improved cleaner for small diameter tubes, such as are used in heat exchange units and similar apparatus. The new Roto Junior cleaner is air driven and is entirely self contained, permitting a number of them to be operated simultaneuosly in the same unit. Features added are a new scraper head with inexpensive replaceable blades, a universal joint for attaching the cleaning heads to the motor and a quick-acting air valve directly behind the motor for the convenience of the operator and one man operation.

The Roto Junior will effectively clean straight tubes as small as 5/8" O.D. and curved tubes with short radius bends as small as 7/8" O.D. The motor has only two moving parts. It operates at pressures of from 30 to 75 pounds, with an air consumption of from 12 to 20 cubic feet of free air per minute. Very little headroom is required, and either horizontal or vertical tubes can be cleaned without removing the tube bundle if so desired. The speed and convenience of the Roto Junior allows more frequent cleaning, with a higher resultant efficiency of the unit cleaned, it is said.

Air Compressors

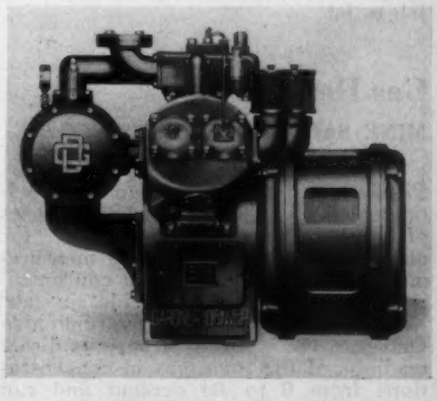
GARDNER-DENVER COMPANY

Gardner-Denver Company, Quincy, Illinois, announces a new line of three-cylinder air compressors, known as "WBR", which are available in sizes ranging from 113 to 194 cubic feet per minute displacement.

These new compressors, which are part of the WB line, combine a number of unusual features of design which materially increase their efficiency and value, it is said.

One of the most distinctive features of the WBR compressor is the use of two small low pressure cylinders, instead of one large one, resulting in lower air temperature with corresponding saving in horsepower. Cylinder walls are water-cooled to provide lower wall temperature with better lubrication and longer life. In addition, the two-stage construction, with water-cooled cylinders and intercooler, assures sustained high efficiency.

A force feed pressure lubrication system is used, oil being delivered to the bearings by a plunger pump. Pistons and cylinder walls are lubricated by the oil



Gardner-Denver Compressor

spray of the crank pin. The compressor may be run either direction.

The main bearings are of the Timken heavy-duty, tapered roller type. This use of roller bearings, according to the maker, decreases the distance of the center of the main bearings to the center of the crank pin, making possible the use of the compact and rigid crank shaft.

The crank shaft itself is of chrome-nickel-molybdenum alloy, ground to size and accurately counterweighted for best running balance. Connecting rods are of drop forged steel, heat treated, having steel backed, babbit lined, ribbon-type crank pin bearings. Pistons are of the light weight automotive type, ground to fit the cylinder bore, and three compression and one oil ring are used on each piston. Valves are of the "cushioned" noiseless automotive plate type, the cushioning being accomplished by the use of an air cushion pocket in the guard or bumper over each valve.

Acetylene Generator

THE LINDE AIR PRODUCTS CO.

The Linde Air Products Company, New York City, has announced a new small-size medium-pressure acetylene generator for portable or stationary service. Known as the Oxweld Type MP-6 medium pressure generator, this latest addition to the Oxweld line of generating equipment has a 50-pound carbide capacity with a double rating of 100 cubic feet of acetylene per hour. Developed for portable or stationary use with any type of oxy-acetylene cutting or welding apparatus, it meets the demand for small, rugged, low-priced generating equipment of modern design, the manufacturer claims.

A handwheel at the generator top makes it possible to control the carbide feed so that acetylene at any desired pressure up to 14 pounds per square inch may be obtained. The carbide feeding mechanism incorporates the same principle of gravity type, pressure diaphragm-control as the larger Oxweld Types MP-4 and MP15.

No piping is exposed, and such operating mechanisms as the feed control, carbide hopper, hydraulic back pressure valve, and filter are all assembled within the dome-shaped top of the generator. The dome may be tilted back if access to the interior is necessary. It has been tested and accepted by the Underwriters' Laboratories at the double rating for generating capacity. In addition, it has been listed for both stationary and portable service. The generator can be mounted on a truck for transportation from job to job.

Gas Detector

MINE SAFETY APPLIANCES CO.

Mine Safety Appliances Company, Pittsburgh, recently announced development in its Research Laboratories of a hand-operated instrument for quick, accurate detection and measurement of low but dangerous concentrations of hydrogen sulphide in air. Known as the MSA Hydrogen Sulphide Detector, the instrument permits direct readings of the toxic gas in concentrations from 0 to .04 percent and can be operated by the ordinary workman.

Diesel Tractors

CATERPILLAR TRACTOR COMPANY

Caterpillar Tractor Company, Peoria, Illinois, has announced four new Diesel tractors that will be known as RD-8, RD-7, RD-6 and RD-4, and a spark ignition machine called the "Thirty." The first three models succeed the Diesel Seventy-Five, Diesel Fifty and Diesel Forty, formerly manufactured by the company and are comparable to them in everything except power. The new models are much more powerful than the old, it is claimed, because of the increase in cylinder bore from 5¼ to 5¾ inches.

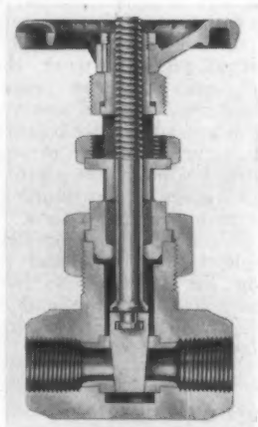
The new RD-4 and Thirty are companions in outer dimensions, chassis, transmission and tracks. Many of the engine parts also are interchangeable. The new machines have a higher ground clearance than the old models. The Diesel model weighs only 400 pounds more than the new Thirty and about 300 pounds less than the old. The RD-4 consumes about 1¼ gallons of low cost fuel per hour.

Valve

CHAPMAN VALVE MANUFACTURING COMPANY

The Chapman Valve Manufacturing Company, Indian Orchard, Mass., announces a new gate valve, machined from solid steel bar stock and carrying a five-year guarantee.

The new valve, List 960, is made in all standard sizes from ¼- in two-inch. It is designed for all services up to 600 pounds pressure at 800°F. Sizes ¼" to 1" are designed for cold working pressures of 2500 pounds; larger sizes for 1500 pounds.



Chapman Valve

It is stated that the new valve offers economies not only because of its wearing qualities and freedom from repairs, but also because it can be employed as standard small-valve equipment throughout a power or process system.

The valve has no pockets, raised seats or constrictions; in the open position it forms a virtually unbroken continuation of the pipe line. It can be repacked under pressure.

The valve is fitted with stainless steel valve stem, plug and seat rings. These parts are easily renewable. The unconditional guarantee which accompanies each valve states that the company "agrees to replace without charge any working part or parts of any valve which fails from any cause within five years from the date of installation."

For extreme corrosive service the List 960 is manufactured in monel, stainless and other special alloys.

Cable Connector

THE LINCOLN ELECTRIC COMPANY

A new type of quick-detachable connector, designed for use in connecting welding or electrode cable and which locks in position and cannot work loose nor be accidentally pulled apart, is announced by The Lincoln Electric Company, Cleveland, Ohio.

This new connector provides a quick method of connecting cables. Its operation is so simple that connection can be made in the dark.

In operating the connector, the plug is inserted in the jack and a twist of the wrist locks the connection. To disconnect, the procedure is reversed.

Meters

ROOTS-CONNERSVILLE BLOWER CORPORATION

Roots-Connersville Blower Corporation, Connersville, Indiana, has extended its line of rotary displacement meters by adding a new smaller sized unit, the 2½ by 7 meter.

This meter is built for line pressures up to 25 pounds per square inch, having a normal capacity of 5000 cubic feet per hour, at one-inch water gauge differential, but maintaining commercial accuracy on loads ranging from 10 to 150 percent of normal rating.

This meter is compact, measuring 22x14x15 inches. While regularly supplied with base for foundation mounting, it can also be furnished with special bottom pipe plate, permitting direct mounting in a vertical gas line. Standard equipment includes a differential gauge, also a register reading in cubic feet of gas passing meter. Indicating or recording instruments can be supplied when required by installation.

While of smaller capacity, this 2½x7 meter retains the same characteristic low operating differential pressures; rotary motion, giving reliable accuracy throughout wide variations in rate of flow; all iron and steel construction, and large capacity in a single unit in relatively small space.

It is applicable to small gas plant operation, industrial and commercial gas consumer installations, low pressure natural gas wells and transmission lines, chemical processes, sewage gas measurement, or measuring gas engine fuel consumption.

Electrically Driven Centrifuges
Hand Centrifuges
WRITE
WILLIAMS, BROWN & EARLE, Inc.
Manufacturers of Laboratory Apparatus
918 Chestnut St. Philadelphia, Pa.

DISMANTLING
CARNEGIE OIL REFINERY
CARNEGIE, PENNA.
Boilers, tanks, pipe, pumps, wax presses, ice-making machinery, complete filter units and other refinery equipment. Good reusable condition. Bargain prices.
THE M. N. LANDAY CO.
1304 Clark Building, Pittsburgh, Pa.

CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Pumps

Worthington Pump and Machinery Corporation, Harrison, N. J., has released Bulletin W-312-B1A dealing with its single stage volute Type LT centrifugal pumps for pumping hot and volatile liquids, and Bulletin W-102-B1 covering Worthington horizontal duplex pumps for general services, Turret type, for handling liquids at pressures up to 200 pounds.

Pumps

Quimby Pump Company, 340 Thomas Street, Newark, N. J., has published Bulletin R-200 dealing with Rotex pumps which are built in capacities from 14 to 400 gallons per minute at speeds ranging from 3500 to 585 r.p.m.

Pumps

Morris Machine Works, Baldwinsville, N. Y., has issued a handy reference bulletin, No. 157, dealing with centrifugal pumps for virtually every purpose. The bulletin also includes information useful to centrifugal pump users.

Pumping

Ingersoll-Rand Company, 11 Broadway, New York, is distributing Bulletin 9042 dealing with the I-R method of air lift pumping of water, oil or other fluids. Advantages of air lift pumping for certain conditions are brought out, several applications illustrated and described, theory of air-lift pumping is set forth in detail and a number of different compressors for supplying air are shown.

Tube Cleaner

The Roto Company, 147 Sussex Avenue, Newark, N. J., is distributing a new bulletin dealing in detail with its new and improved cleaner for small diameter tubes such as are used in heat exchanger and similar apparatus. The device is trade named Roto Junior and is said to be a simple, self-contained, powerful, efficient and durable air-driven cleaner for small tubes.

Hose Mask

Mine Safety Appliances Company, Pittsburgh, has issued Bulletin EB-1 dealing with MSA fresh air hose masks, which is so completely illustrated and contains all pertinent information on the company's line of masks.

Pipe

Republic Steel Corporation, Central Alloy Division, Massillon, Ohio, is distributing a new 16-page two-color folder, "The Greatest Pipe Show on Earth," which lists and describes the various types of tubular products manufactured by the company and its subsidiary, Steel & Tubes, Inc. It is indexed for added convenience.

Worm Gears

De Laval Steam Turbine Company, Trenton, N. J., is distributing a technical reprint, "Worm Gears, Selection, Application, Maintenance," by M. M. Mills, engineer, worm gear division, De Laval Steam Turbine Company. Principles controlling design, ratios available, efficiencies to be expected, the requirements as to lubrication and the standard formulas according to which such gears are now rated, are outlined; also methods of installation.

Gas Detector

Mine Safety Appliances Company, Pittsburgh, has prepared literature dealing with its new hand operated instrument for quick and accurate detection of low but dangerous concentrations of hydrogen sulfide in air. Request Bulletin DY-1.

Chlorinated Hydrocarbons

The R & H Chemicals Department of E. I. du Pont de Nemours & Company, Wilmington, Delaware, recently has released a technical bulletin of chlorinated hydrocarbons, listing their characteristics, properties, specifications and other useful information. Sixteen of the more important chlorinated hydrocarbons, all of which are now in commercial use, are described. These products are non-flammable and non-explosive with the exception of a few which are considered only moderately flammable. Information is provided on flammability, classification, stability, effect on common metals, selective solvent action and commercial properties.

Refractories

General Refractories Company, 106 South 16th Street, Philadelphia, has ready for distribution a pamphlet entitled "A New Application of the Ritex Process to the Manufacturer of Chrome Brick," written by R. P. Heuer, director of research for the company.

Repair of Cast Iron

Linde Air Products Company, 30 East 42nd Street, New York, has released a well illustrated booklet, "The Repair of Damaged Cast-Iron Machinery." It is a consolidation and orderly arrangement of the known facts regarding the repair of damaged cast-iron machinery by the oxy-acetylene process.

Friction Linings

Johns-Manville, 22 East 40th Street, New York, has released a new brochure catalog of J-M friction materials of both flexible and rigid styles. It contains brief descriptions of the complete line of friction materials, including woven, compressed, and folded and compressed products of the flexible types and the friction block and moulded varieties of the rigid styles. The title is "Johns-Manville Industrial Friction Materials."

Diesel Engines

Chicago Pneumatic Tool Company, 6 East 44th Street, New York, in Bulletin 779 gives a comprehensive catalog of its line of Diesel engines. Functioning of separate parts of the engine is described in detail and illustrations of the separate parts are given.

Alloys

The International Nickel Company, 67 Wall Street, New York, has issued "Monel Metal Accessories," Bulletin H-2, where will be found much of real interest in the plant where bolts, nuts, pins, washers, and other accessories must be watched as possible source of corrosion. Dimension tables for the principle items are included.

Shut Off Valves and Flange Unions

Kerotest Manufacturing Company, 2525 Liberty Avenue, Pittsburgh, Pa., has issued two informative bulletins. Bulletin 118 describes its newest type Gauge Shut-Off Valves made of drop forged, heat-treated alloy steel. Bulletin 116 describes the Kerotest Ring-Joint Flange Unions made of heat-treated steel forgings. Copies of these new bulletins, just off the press, are available by addressing this publication or the manufacturer direct.

Welding

The Lincoln Electric Company, Cleveland, Ohio, has ready for distribution an attractive 42-page bulletin on "Automatic Arc Welding by the Electronic Tornado."

Centrifugal Pumps

Lawrence Pump & Engine Company, Lawrence, Massachusetts, has issued an eight-page bulletin describing its "Electropump," a compact centrifugal pumping unit for small and moderate capacities.

Potentiometer Controllers

The Foxboro Company, Foxboro, Massachusetts, has announced the recent publication of a new 20-page bulletin, No. 202, covering its complete line of potentiometer and resistance thermometer controllers.

Lathes

South Bend Lathe Works, South Bend, Indiana, has announced publication of a new two-color, 24-page catalog describing the new nine-inch "Workshop" precision lathe manufactured by the company. The booklet contains a variety of illustrations and data of interest to lathe users.

Metal Cleaning

Magnus Chemical Company, Garwood, New Jersey, recently issued a book that is intended to provide a ready reference and guide for the use of those directly interested in or concerned with metal cleaning. The book is called "The Metal Cleaning Handbook."

Only a limited number of copies are available. A request from an inquirer on a business letterhead, giving the official title or position, brings a copy. To all other, copies are sent upon receipt of the nominal sum of $1.00 to cover the cost of publication.

Alloys

The International Nickel Company, 67 Wall Street, New York, has published a technical article "Use of Nickel Bearing Alloys in Oil Refineries" which describes the wide range of nickel alloys available for use in petroleum refinery equipment.

Compressors

Worthington Pump and Machinery Corporation, Harrison, N. J., has published new bulletins dealing with compressors. Bulletin L-611-B4a covers Worthington steam- and motor-driven, 11- and 13-inch stroke single stage compressors, and Bulletin L-611-B5a covers same types of compressors in 5-, 7- and 9-inch stroke. Bulletin W-412.-B5, also recently issued deals with Worthington totally enclosed, horizontal duplex power pumps for the petroleum industry.

Herringbone Gear Reducer

A new 32-page catalog No. 1519 has been completed by Link-Belt Company, Philadelphia, on its line of single, double and triple reduction Herringbone-gear speed reducers for large speed ratios, and heavy and shock loads. Particularly stressed is the company's "RC" double-reduction reducer, which is made up of a herringbone-gear first reduction unit, and a finished-steel roller chain drive for the second reduction. Numerous example installations are sketched, with definite solutions of actual driving problems, to show the flexibility and relative advantages of this form of double-reduction unit. Another feature of the book is that it rates all reducers on the basis of the recently recommended practice of the American Gear Manufacturing Association.

USE THIS COUPON
(Address manufacturer direct)

. . . . . .

. . . . . .

Please send me, without obligation, free booklet described in December, 1935, issue of REFINER AND NATURAL GASOLINE MANUFACTURER.

NAME . . . . . .

ADDRESS . . . . . .

VISES

THAT HAVE EXTRA TOOL FEATURES...

IF you are used to taking pipe vises for granted, stop, look and listen.

- Pipe vises are usually plain substantial devices for holding pipe, but RIGID vises are much more than that.
- They are all equipped with handy efficient pipe benders.
- They all have pipe rests built into them.
- Yoke and chain vise stands have handy tool trays.
- Yoke and chain post vises are equipped with oil can holders.
- And in 2" and 2½" capacities all RIGID vises are equipped with No-Mar jaws for nickel pipe.

These features make it well worth your while to ask for RIGIDs when you buy vises. See your supply store.

THE RIDGE TOOL CO., ELYRIA, OHIO, U. S. A.

RIGID

PIPE WRENCHES, CUTTERS, THREADERS, VISES

Advertisers' Index

Alco Products, Inc. 4a
American Manganese Steel Company 25a
American Meter Company 63a
Armstrong Machine Works 22a-23a
Automatic Tube Cleaner Company 58a
American Sand-Banum Company 53a

The Bristol Company 26a
The Brown Instrument Company 13a

The Chaplin-Fulton Manufacturing Company 62a
Chapman Valve Manufacturing Company 61a
Chessman-Elliott Company 53a
Chicago Bridge & Iron Works 47a
Cork Insulation Company 49a

DeLaval Steam Turbine Company 20a
J. P. Devine Manufacturing Company 46a
Diamond Alkali Company 21a
E. I. DuPont de Nemours & Company 28a

The Eagle-Picher Lead Company 27a
Elliott Company 6a
Fisher Governor Company 48a
Fluor Corporation 44a
Foster Wheeler Corporation 31a

The Garlock Packing Company 10a
Gasoline Products Company 55a
General Electric Company 16a
Goulds Pumps, Inc. 19a

The Haden Lime Company 60a

Jerguson Gage & Valve Company 32a
Johns-Manville Corporation 9a

The M. W. Kellogg Company 8a
The Key Company 60a
Kieley & Mueller, Inc. 52a

The LeBour Company 58a
The M. N. Landry Company 66a
Landis Machine Company 35a
Liberty Manufacturing Company 45a
The Lummus Company ..... Second Cover
The Lunkenheimer Company 56a

Maintenance Engineering Corporation 40a
The Marley Company 24a
Mason-Neilan Regulator Company 5a
Mathieson Alkali Works, Inc. 12a
A. Y. McDonald Manufacturing Company ..... Fourth Cover
Merco Nordstrom Valve Company 7a
Mine Safety Appliances Company 32a
Multi-Metal Wire Cloth Company 42a

National Tube Company 36a
Newark Wire Cloth Company 46a

Oakite Products, Inc. 52a

Pittsburgh Steel Company 30a

Reading-Pratt & Cady Company 29a
Republic Steel Corporation ..... 11a and 57a
The Ridge Tool Company 68a
The Roto Company 62a

The Sarco Company 43a
Scoville Manufacturing Company ..... Third Cover
Shand & Jurs Company 50a
Southern Alkali Corporation 18a
Sun Shipbuilding & Dry Dock Company 17a

Taylor Instrument Companies 14a-15a
Troy Engine & Machine Company 38a

Universal Oil Products Company 59a

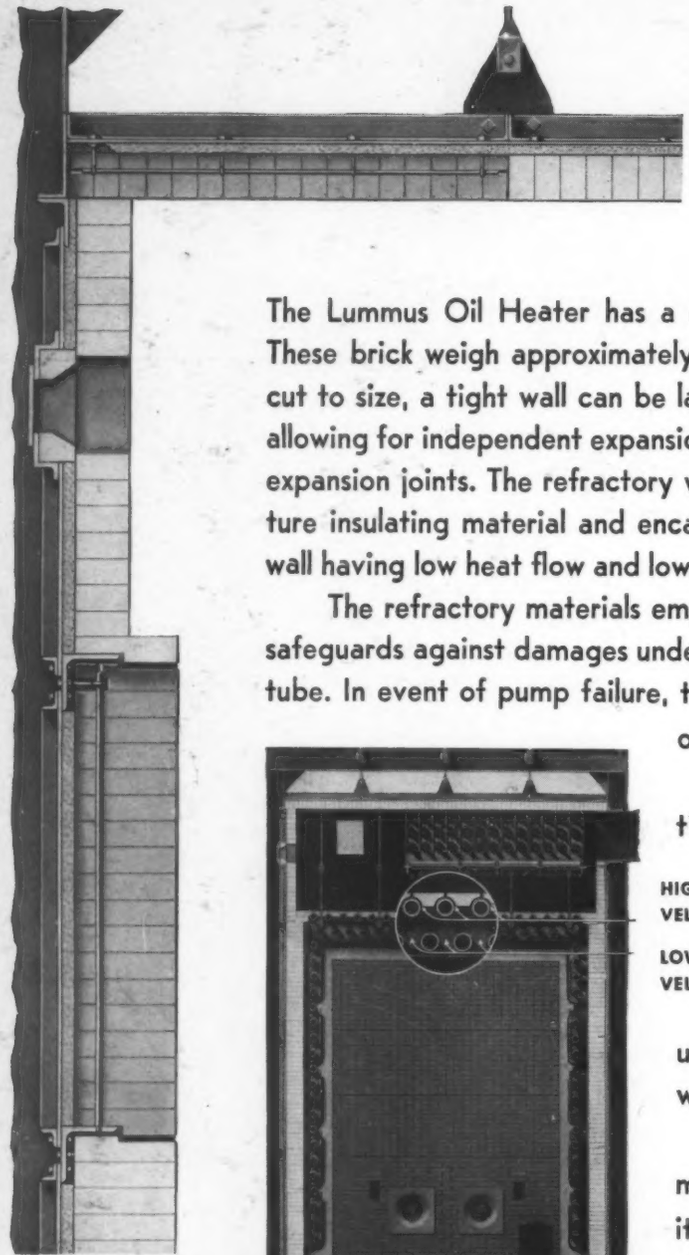
Henry Vogt Machine Company 34a

Webster Engineering Company ..... First Cover
Williams, Brown & Earle, Inc. 66a

John Zink 33a

THE WEBSTER ENGINEERING COMPANY
BEST WISHES FOR A MERRY CHRISTMAS AND A HAPPY NEW YEAR TO ALL OUR FRIENDS IN THE INDUSTRY
DISTRICT OFFICES
Atlanta, Georgia ..... F. J. Evans Engr. Co., ... 301 Red Rock Bldg.
Birmingham, Alabama ..... F. J. Evans Engr. Co. ..... 1305 Watts Bldg.
Boston, Massachusetts ..... Eastern Appliance Co. ..... 250 Stuart St.
Chicago, Illinois ..... Surface Combustion Corp. ..... 122 S. Michigan Ave.
Cleveland, Ohio ..... Surface Combustion Corp. ..... 3014 Kensington Road
Columbus, Ohio ..... Surface Combustion Corp. ..... 400 Dublin Ave.
Detroit, Michigan ..... Surface Combustion Corp. ..... General Motors Bldg.
Dallas, Texas ..... Gas Heating & Specialty Co. .... Second Unit Santa Fe Bldg.
Faribault, Minnesota ..... Surface Combustion Corp. ..... 204 Central Ave.
Houston, Texas ..... Mechanical Equipment Co. ..... 923 M. & M. Bldg.
Kansas City, Missouri ..... Surface Combustion Corp. ..... 525 Armour Blvd.
Kansas City, Missouri ..... Hubbard Sales Co. ..... 2409 Harrison St.
Los Angeles, California ..... Natural Gas Equipment, Inc. ... 718 Petroleum Securities Bldg.
Memphis, Tennessee ..... F. J. Evans Engr. Co. ..... Fidelity Bank Bldg.
New York, N. Y. ..... Surface Combustion Corp. ..... 60 Wall Street
Philadelphia, Pennsylvania ..... Surface Combustion Corp. ..... Atlantic Bldg.
Pittsburgh, Pennsylvania ..... Surface Combustion Corp. ..... Grant Bldg.
Rochester, N. Y. ..... Surface Combustion Corp. ..... 232 East Avenue
San Francisco, California ..... Natural Gas Equipment, Inc. ..... 1123 Harrison St.
St. Louis, Missouri ..... Surface Combustion Corp. ..... 455 Paul Brown Bldg.
Syracuse, New York ..... Surface Combustion Corp. ..... 109 Dunham Road
Toledo, Ohio ..... Surface Combustion Corp. ..... 2375 Dorr Street
Division of
THE SURFACE COMBUSTION CORP.
Toledo, Ohio
COMBUSTION

THE LUMMUS LIGHT WEIGHT INSULATED REFRACTORY WALLS



Details of the Lummus Insulating Refractory Wall and Arch

The Lummus Oil Heater has a nine-inch refractory wall of insulating firebrick. These brick weigh approximately one-fourth of that of standard firebrick. Being cut to size, a tight wall can be laid without the use of any cementing material allowing for independent expansion of each brick. This eliminates the necessity of expansion joints. The refractory wall is backed up with one-inch of high temperature insulating material and encased in a steel casing. This results in an air-tight wall having low heat flow and low heat storage.

The refractory materials employed will withstand extreme temperatures. This safeguards against damages under unusual conditions such as fires due to a burst tube. In event of pump failure, the low heat storage capacity avoids coking or overheating of the oil.

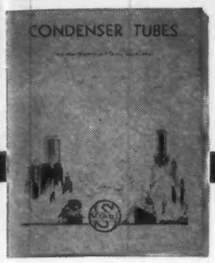
The construction of the walls in the convection section and the arch are identical with the furnace walls except that due to the lower temperature, only four and one-half inches of the insulating firebrick and one and one-half inches of insulation are used. Both are steel encased as are the furnace walls.

While this type of wall and arch is recommended, the Lummus design of heater is not limited to its use. A standard firebrick wall or any of the sectionally supported walls and arches can be used.

THE LUMMUS COMPANY, 50 CHURCH STREET, NEW YORK, N. Y. • BUSH HOUSE, ALDWYCH, LONDON, W. C. 2

LUMMUS

PETROLEUM REFINING PLANTS



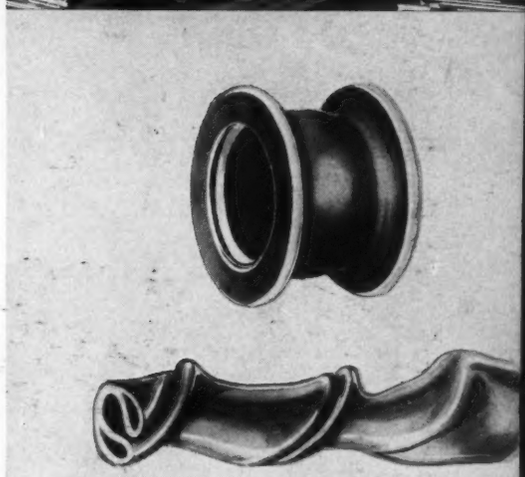
CONDENSER AND HEAT EXCHANGER TUBES

WITH high temperatures, high pressures, and contact with sulphur compounds the rule rather than the exception, heat exchanger and condenser tubes in the oil refining field encounter even more severe conditions than are met in regular heat transfer service. To successfully meet these rigorous conditions, the tubes must be uniform in alloy and mechanical properties . . . but equally important is the use of the most suitable alloy.

In many cases, a condenser tube manufacturer—when informed as to operating conditions—can be of considerable aid to oil refiners. His knowledge of tube performance in many other refineries enables him to help select the proper alloy for the particular conditions met. To this end, the Scovill staff of engineers will gladly work with you.

For some installations, tubes of red brass with an 85-15 composition have proved most successful. In others, Scovill Cup Drawn Admiralty has been the answer. Adnic, a high nickel content tube, has been notably successful where requirements indicated its use.

The experience and advice of the Scovill technical staff is yours for the asking. It will cost you nothing, but may save you a considerable sum on tube costs. Further details of Scovill service may be found in the booklet, "Condenser Tubes." Write for it to Scovill Manufacturing Company, 15 Mill Street, Waterbury, Connecticut.



A few of the tests made on all Scovill Tubing
Top: Electrolysis board where copper content is determined
Center: Gauging inspection performed on all Scovill Tubing
Bottom: Scovill Cup-Drawn Admiralty Tubing samples tortured by expanding, beading, twisting, flattening, bending and flaring. ***No failures!***

S C SCOVILL V I L L

SCOVILL MANUFACTURING COMPANY, WATERBURY, CONN.

Boston Providence New York Philadelphia Atlanta Syracuse Pittsburgh Detroit Chicago Cincinnati San Francisco Los Angeles • IN EUROPE: The Hague, Holland • IN CANADA: 334 King Street, E., Toronto, Ontario

It's *CHECK-UP* Time

To Reduce Waste and Speed Up Handling in 1936

Check Up Now on Your Fittings

The surest way to increase profit is to decrease waste and speed up handling.

McDonald equipment is specifically designed for this purpose.

A list of McDonald customers reads like a bluebook of the industry because leading companies know, from actual service records, the type of service they can expect from McDonald products. Advanced engineering, honest manufacture and exacting standards of inspection all help to provide that EXTRA degree of value that the careful buyer insists upon.

The items pictured on this page have all proved their value in the test of everyday service.

The complete line is described in the McDonald Oil Equipment Catalog, a copy of which will be mailed on request.

A. Y. McDONALD MFG. CO.
"The Home of the Swing Joint"
DUBUQUE, IOWA

There's a McDonald Branch or Distributor Near You

Plate 807-A—45° Swivel Type Car Reducer Coupling—Male Outlet Thread—all bronze. Sizes: 5" x 2"; 5" x 2½"; 5" x 3"; 5" x 4".

Plate 910—Pressure Relief Valve. Positive in action. Extra large pressure-relieving capacity. Sizes: ¾", 1", 1¼", 1½", 2", 2½", 3". All Bronze in sizes to 2"; above 2", Iron Body, Bronze Mounted.

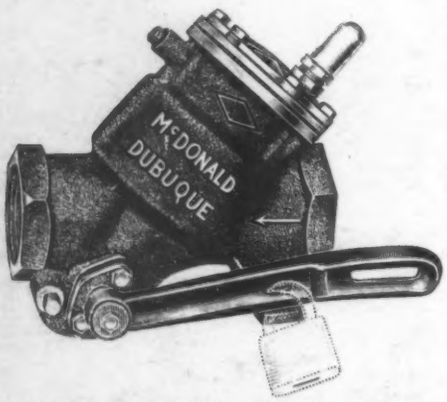


Plate 945—Slo-Self-Closing Loading Line Valve—Patented. A positive necessity for pressure loading. Prevents hammering and excessive pressure on line when valve is closed by operator. Saves its cost many times each year. Sizes: 2", 2½", 3".

Plate 914—Line Strainer. Prevents foreign matter from passing through pump. No restriction to flow. A necessity on every pump installation. Sizes: 1½", 2", 2½", 3".

Plate 917—45° Swivel Type Car Reducer Coupling—Female Outlet Thread—all bronze. Sizes: 5" x 2"; 5" x 2½"; 5" x 3".

Plate 898—Double Swing Joint. A carefully made, all bronze joint for use where space will not permit iron body type. Sizes: ¾", 1", 1¼", 2", 2½", 3". Also furnished in single type—Plate 897.

Plate 814—Double Swing Joint. The kind of swing joint you'd expect from the "Home of the Swing Joint." Iron body, bolted iron gland, bronze ferrule. Sizes: ¾" to 12". Also furnished in single type—Plate 813.

EST. 1858 McDonald

McDONALD